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LOWER MISSISSIPPI REGION COMPREHENSIVE STUDY. APPENDIX L. WATER--ETC(U)
1974

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Lower Mississippi Region

Comprehensive Study

Appendix L

Water Quality and Pollution

1974

This appendix is one of a series of 22 documents comprising the complete Lower Mississippi Region Comprehensive Study. A list of the documents is shown below.

Main Report

Appendixes

Appendix	Description	Appendix	Description
A	History of Study	K	M and I Water Supply
B	Economics	L	Water Quality and Pollution
C	Regional Climatology, Hydrology & Geology	M	Health Aspects
D	Inventory of Facilities	N	Recreation
E	Flood Problems	O	Coastal and Estuarine Resources
F	Land Resources	P	Archeological and Historical Resources
G	Related Mineral Resources	Q	Fish and Wildlife
H	Irrigation	R	Power
I	Agricultural Land Drainage	S	Sediment and Erosion
J	Navigation	T	Plan Formulation
		U	The Environment

WATER QUALITY AND POLLUTION.

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LOWER MISSISSIPPI REGION COMPREHENSIVE STUDY.

Appendix L.

PREPARED UNDER THE SUPERVISION OF
THE LOWER MISSISSIPPI REGION COMPREHENSIVE STUDY
COORDINATING COMMITTEE

410 262

LB

This report was prepared at field level by the Lower Mississippi Region Comprehensive Study Coordinating Committee and is subject to review by interested Federal agencies at the departmental level, by Governors of the affected States, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

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The photographs in this appendix were furnished by:

INTRODUCTION

GENERAL

Rivers, bayous, drainage ditches, sloughs, inland waterways, lakes, reservoirs, marshes, swamps, and coastal waters form a network of surface waters in the Lower Mississippi Region. These surface waters, together with the extensive and productive fresh-water aquifers that underlie the region, constitute a vital part of the resource base that sustains life in the region. This resource is renewable in quantity through natural replenishment, and in some respects renewable in quality through natural processes of self-purification. However, the many and increasing uses to which water is put often result in degradation of natural quality which self-purification cannot correct. Proper development and effective management is essential if we are to insure the future maximum usefulness of this important resource.

PURPOSE

The purposes of this appendix are: (1) to discuss present water uses and conditions of man-made and natural pollution in the Lower Mississippi Region; (2) to describe the quality of surface and ground waters within the region; (3) to summarize existing water quality management programs, including contemporary treatment methods and their effectiveness; and (4) to quantify, either explicitly or in general terms where information is unavailable, waste production and net pollution loadings in terms of biodegradable wastes, bacteria, and non-biodegradable wastes.

SCOPE

This investigation is of the reconnaissance type intended to provide broad-scaled analyses based on existing data and reports. It provides a general guide to formulation of a water quality plan for the Lower Mississippi Region. Conditional pollution forecasts are developed for each of 10 Water Resource Planning Areas ~~(WRPA's, figure 1)~~ covering bacteria and organic waste loads from municipal, industrial, and agricultural sources. These forecasts stem from economic forecasts relating to population and employment contained in Appendix B, Economics, and livestock numbers shown in Appendix H, Irrigation. Because of a lack of information, such wastes as heavy metals, nutrients, toxics, odor, color, phenolics, pH, thermal wastes, and oil and grease are discussed only in general terms. The study places emphasis on large sources of pollution and is primarily concerned with large streams.

Biodegradable organic and bacterial waste load forecasts are prepared for two programs:

Program A - National Income: Economic forecasts reflecting the Water Resources Council's predictions of national economic growth. Three underlying assumptions dominate Program A: (1) United States population will nearly double between 1968 and 2020, (2) productivity and income per man-hour worked will increase at approximately 3 percent per year, and (3) goals of full employment and no major wars will be realized.

Program B - Regional Development: Economic forecasts reflecting the assumption that the Lower Mississippi Region, by and large, will grow economically to 2020 at an average rate at least equal to the rate of expansion of the Gross National Product projected for the Nation. Thus, Program B forecasts that economic growth as measured by employment will be slightly higher than under Program A assumptions.

Non-BOD waste loads, with the exception of bacteria, were not calculated for this appendix. Although discussed in some detail in the planning area reports for WRPA's 1 and 9, where the largest sources of these wastes are located, regional data were neither sufficiently detailed nor accessible to permit load calculations.

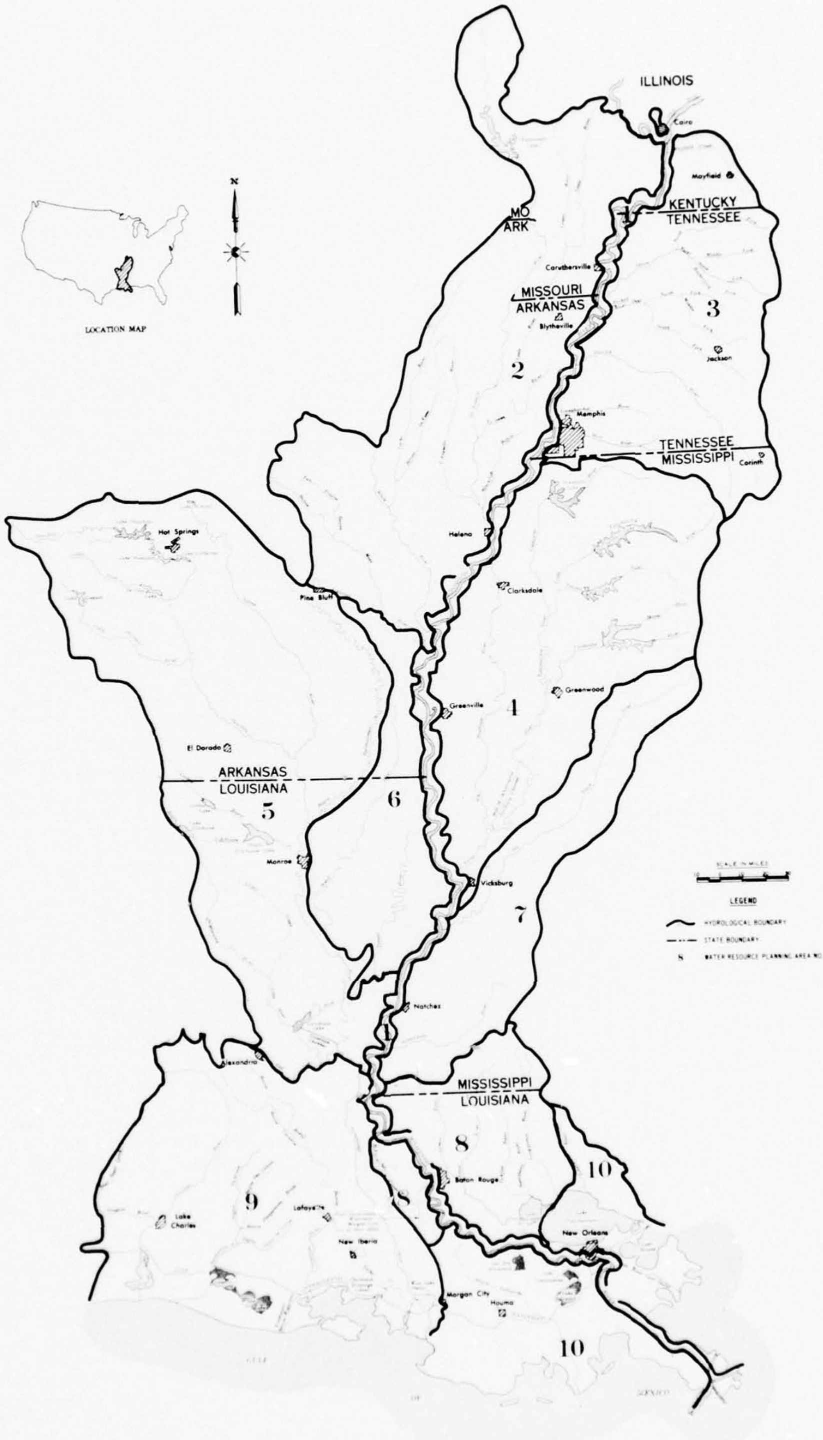
DEFINITION OF TERMS

Throughout this appendix the following terms are used:

Biodegradable organic wastes - wastes, other than bacteria, that can be decomposed or mineralized by microorganisms in the soil, bodies of water or wastewater treatment plants. In this report the wastes are measured and expressed in terms of 5-day BOD (BOD_5) or the number of pounds of oxygen required for the first 5 days of their decomposition.

Nonbiodegradable organic and inorganic wastes - wastes, other than bacteria, which cannot be removed or are difficult to remove from water by the action of microorganisms.

Bacteria - microorganisms that include disease-causing pathogenic bacteria. Coliform bacteria are taken as an indication of fecal contamination when they occur in concentrations that exceed the standards for various water uses.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

REGIONAL MAP

FIGURE 1

REGIONAL SUMMARY

STUDY AREA DESCRIPTION

Population

A total of 6,293,233 people inhabited the Lower Mississippi Region in 1970. This population was distributed over all or portions of 188 counties and parishes in parts of seven states bordering the Mississippi River from Cairo, Illinois, to the Gulf of Mexico. Forty-six counties are in Arkansas, 14 in Missouri, 2 in Illinois, 7 in Kentucky, 19 in Tennessee, 43 in Mississippi; and 57 parishes are in Louisiana. Comprising a total land and water area of 102,403 square miles (sq. mi.), 25,663 sq. mi. (25.1 percent of the region) are in Arkansas, 5,769 sq. mi. (5.6 percent) in Missouri, 34 sq. mi. (0.03 percent) in Illinois, 1,238 sq. mi. (1.2 percent) in Kentucky, 8,195 sq. mi. (8.0 percent) in Tennessee, 22,248 sq. mi. (21.7 percent) in Mississippi; and 39,257 sq. mi. (38.4 percent) in Louisiana.

The urban population of the Lower Mississippi Region totaled 3,734,000 in 1970. Of this total, approximately 3,189,000 people lived in 118 communities of 5,000 or more inhabitants. New Orleans, Louisiana, was the largest community with a Standard Metropolitan Statistical Area (SMSA) population of 1,045,809 inhabitants in 1970. The Memphis SMSA was second largest with 770,120 inhabitants, and the Baton Rouge, Louisiana, SMSA was third largest with 285,167 inhabitants in 1970. In 1970 there were 261 communities of 1,000 to less than 5,000 inhabitants in the region with a total population of about 591,000.

Figure 1 shows limits of the study area and the planning subdivisions used in development of a comprehensive program for the region. Present and projected population for the region is presented in table 1.

Economy

Economic activities depend on water but often foul the water during use. Continuing economic development tends to reinforce water dependency and increase waste-water output. Population growth, increasing industrialization, expanding and intensified agricultural activity, increasing mineral production, and soaring electric power needs - important sectors of the economy - cause ever increasing demands for water. These water requirements, along with public demands for water-related recreation, for preservation and enhancement of aquatic life and for an aesthetic natural environment, cause an increasing need for wastewater management.

Table 1 - Population, Lower Mississippi Region

Base Population 1970	Program	Projected Population 1980	2000	2020
Total Population				
	A	6,741,000	8,156,000	10,196,000
6,293,233	B	7,285,000	9,188,000	11,655,000
Urban Population 1/				
	A	4,281,000	5,738,000	7,745,000
3,734,000	B	4,662,000	6,432,000	8,858,000

1/ Communities of 2,500 or more inhabitants.

The total employment in the Lower Mississippi Region in 1968 was 2,212,522. This is an increase of 18.1 percent from 1960 when 322,926 (17.2 percent) were in manufacturing, 37,061 (20 percent) in mining, and 296,079 (15.8 percent) in agriculture (which includes forestry and fisheries).

Table 2 indicates the growth of employment to the year 2020 according to projections for Programs A and B.

One thousand fifty-nine industries that discharge waste waters in relatively large quantities with high BOD concentrations are located in the Lower Mississippi Region. The food, paper, chemicals, and petroleum products industries comprise more than 96 percent of the total number that produce BOD wastes in the region. These same industries produce more than 99 percent of the industrial organic wastes and nearly 100 percent of the region's non-BOD wastes. Among these four major industrial groups, food and kindred products and chemicals and allied products industries comprise, respectively, about 55.7 and 25.4 percent of the total number.

Mining operations include metallic and nonmetallic minerals and fuels. WRPA 2 is the leading area with respect to production of metallic minerals. Of the 12 different nonmetallic minerals mined in the region, five are produced in WRPA 5, and three each are produced in WRPA's 8 and 10. The leading area in production of natural gas and natural gas liquids is WRPA 9. WRPA 10 leads in petroleum production.

Agricultural production reports of livestock and poultry place cattle and calves, and hogs and pigs among the most numerous of farm animals. In 1970, there were 3,860,500 cattle and calves and 1,201,400

hogs and pigs in the Lower Mississippi Region. Table 3 indicates the projected increases in production to the year 2020 for Programs A and B.

Table 2 - Employment, Lower Mississippi Region

Program	Year	Employment
A	1968	2,212,500
	1980	2,416,000
	2000	3,043,700
	2020	3,917,000
B	1968	2,212,500
	1980	2,649,000
	2000	3,519,000
	2020	4,620,000

Table 3 - Numbers of Livestock and Poultry, Lower Mississippi Region

	Number of Animals				
Category	1970	Program	1980	2000	2020
Cattle and Calves	3,860,500	A	4,916,900	6,618,500	8,888,600
		B	4,916,900	7,099,800	9,545,100
Milk Cows	294,300	A	270,200	333,700	407,500
		B	270,200	358,400	437,400
Hogs and Pigs	1,204,400	A	1,437,300	1,795,200	2,330,500
		B	1,437,300	1,928,600	2,327,500
Sheep and Lambs	162,500	A	124,800	146,600	180,600
		B	124,800	157,700	194,000
Chickens	14,510,100	A	15,940,800	20,405,600	25,848,400
		B	15,940,800	21,920,400	27,756,800
Broilers	89,530,600	A	124,868,300	174,352,000	234,077,800
		B	124,868,300	187,295,700	251,371,400
Turkeys	52,000	A	69,300	97,500	131,800
		B	69,300	104,700	141,600

Streams and Lakes

Table 4 lists 106 of the major streams and lakes in the Lower Mississippi Region that are considered in terms of water quality and pollution. The flow of these rivers is sustained largely by ground water and surface runoff from rainfall. Snowmelt contributes little to the flow of most streams in the region. One exception is the Mississippi River, which seasonally receives vast quantities of melt water in its drainage area above Cairo, Illinois, and from the Ohio River and Missouri River Basins.

The waste assimilative capacities of these streams are least during periods of lowest flow, which generally occur in August, September, and October.

Appendix C, Regional Climatology, Hydrology and Geology, presents information and data on stream management, stream flow, flow velocities, and river profiles.

Table 4 - Selected Streams and Lakes, Lower Mississippi Region

Stream/Lake	
WRPA 1	WRPA 3
Mississippi River	Forked Deer River
	Hatchie River
WRPA 2	Loosahatchie River
Arkansas River	Mayfield Creek
Bayou DeView	Middle Fork, Forked Deer River
Bayou Meto	North Fork, Forked Deer River
Belle Fountain Ditch	Obion River
Big Creek	Rutherford Fork, Obion River
Blackfish Bayou	South Fork, Forked Deer River
Buffalo Creek	Wolf River
Cache River	
Cypress Bayou	WRPA 4
Ditch No. 2	Arkabutla Lake
Lagrue Bayou	Bear Creek
L'Anguille River	Big Sunflower River
Left Hand Chute, Little River	Black Creek
Lick Creek	Bogue Phalia
Right Hand Chute, Little River	Coldwater River
St. Francis River	Deer Creek
St. John's Bayou	Enid Lake, Yacona River
Ten Mile Bayou	Little Tallahatchie River
Tyronza River	Sardis Lake
White River	Skuna River

Table 4 - Selected Streams and Lakes, Lower Mississippi Region (Cont'd)

Stream/Lake
WRPA 4 (Cont'd)
Sunflower River
Tallahatchie River
Tchula Lake
Tillatoba Creek
Whiteoak Bayou
Yalobusha River
Yazoo River
WRPA 5
Bayou Bartholomew
Bayou D'Arbonne
Bayou DeLoutre
Big Bayou
Castor Creek
Catahoula Lake
Dugdemona River
Little Missouri River
Little River
Moro Creek
Ouachita River
Red River (5-9)
Saline River
Smackover Creek
Terre Rouge Creek
WRPA 6
Bayou Cocodrie
Bayou Macon
Boeuf River
Canal 19 - Boeuf River
Lake St. Joseph
Lake St. Peter's Canal
Roundaway Bayou
Tensas River
Turkey Creek
WRPA 7
Big Black River
Homochitto River
WRPA 8
Amite River
Bayou Grosse Tete
Choctaw Bayou
Lake Maurepas
Lake Pontchartrain
Lower Grand River
Tangipahoa River
Thompson Creek
WRPA 9
Atchafalaya River
Bayou Lacassine
Bayou Rapides
Bayou Teche
Calcasieu River
Intracoastal Waterway (9-10)
Mansura Swamp
Mermentau River
Vermilion Bay
Vermilion River
Wax Lake Outlet
West Atchafalaya
WRPA 10
Barataria Bay Waterway
Bayou Chauvin
Bayou Lafourche
Bayou Terrebonne
Black Bayou
Intracoastal Waterway (9-10)
Lake Pontchartrain
Lake Verret
Lockport Canal
Mayrone Canal
Tchefuncta River

Major Aquifers

Ground water supplies in the Lower Mississippi Region are obtained from aquifers that comprise rock units of Quaternary, Tertiary, Cretaceous, Pennsylvanian, Mississippian, Devonian, Cambrian, and Precambrian age. Aquifers that yield major quantities of water for municipal, industrial, and agricultural use are Quaternary alluvial deposits, and Tertiary and Cretaceous formations.

The water quality of these aquifers is summarized in the next section of this report. A listing of aquifer systems by geologic age is given in table 6. For details regarding the regional geology of these systems, reference is made to Appendix C.

PRESENT STATUS

Water Use

Water uses are numerous, but may be grouped into eight major categories which include (1) municipal water supply, (2) industrial water supply, (3) agricultural water supply, (4) cooling, (5) waste assimilation, (6) preservation and enhancement of aquatic life and wildlife, (7) recreation, and (8) navigation. Of these categories, the first four are of specific concern in this study because these uses involve large withdrawals of water and large return flows that are often degraded by use.

Municipal (domestic and commercial) water is used for drinking, culinary purposes, washing, bathing, laundering, waste disposal, heating, watering of lawns and gardens, air conditioning, and fire protection. Such uses apply not only to individual homes and to apartments, but also to hotels, motels, hospitals, office buildings, theaters, and other commercial establishments where people congregate. These many water uses are determined at the points of application by withdrawal from the municipal water distribution system - a system that conveys water of but one quality, regardless whether it is applied for drinking purposes, for waste disposal, or for gardening. This one quality is determined by the use criteria that meet the most stringent quality requirements: drinking water for human consumption. These criteria are given in the section entitled "Water Quality Criteria."

In the Lower Mississippi Region, the water withdrawn in 1970 for all purposes totaled 19,762.7 m.g.d. With a consumptive use of 8,190.8 m.g.d., the return flow of wastewater was 11,571.9 m.g.d. (or 58.6 percent of the total withdrawal). By the year 2020 (according to Program A), the water requirement will increase by 332 percent to 85,349.0 m.g.d. With a projected consumptive use of 18,109.8 m.g.d., the return flow of wastewater is expected to be 67,239.2 m.g.d. (or 78.8 percent of the total withdrawal). This projected return flow is a 481 percent increase above the 1970 figure. As a consequence, increasingly more effective measures will be necessary over the next half century to safeguard the quality of the region's water.

Water withdrawn for municipal supply, industry, and irrigation totaled 10,864.4 m.g.d. in 1970. Of this total, municipal withdrawal accounted for 616.7 m.g.d. (5.7 percent), industrial withdrawal for 5,419.8 m.g.d. (49.9 percent), and irrigation for 4,827.9 m.g.d. (44.4 percent).

Industrial water is used in numerous different manufacturing processes, in steam generation and in sanitation. Production of foods,

chemicals, petrochemicals, metals and textiles requires large quantities of water. Finishing and fabrication processes generally require smaller but still significant amounts of water. Pretreatment of industrial water to meet various in-plant quality requirements is a common practice. Water quality criteria for selected industrial water supplies are given in the secion entitled "Water Quality Criteria."

Agricultural water supplies are used to satisfy farmstead or rural domestic, livestock, and irrigation requirements. The quality standards for all three uses are set to assure the preservation of health of man, his livestock, and his crops.

Use of water by the farming population is in part equivalent to municipal (domestic) water use with drinking, culinary, bathing, and laundering being prime uses. Other important uses involve washing and cooling of vegetables and cleaning of equipment and areas where milk is produced to maintain sanitation.

Cooling water is used throughout industry for maintaining proper operating temperatures of machinery and equipment. Condensers, engine jackets, refrigeration equipment, air conditioning units, and numerous industrial operations utilize water for temperature reduction by waste heat absorption and removal. The three principal types of cooling systems are the once-through system, the open recirculating system, and the closed recirculating system. Water quality requirements for cooling purposes are given in the section entitled "Water Quality Criteria."

Water withdrawn for cooling in thermal electric power generation totaled 4,537.6 m.g.d. in 1970 and, thus, constituted the third largest water withdrawal in the Lower Mississippi Region. By 2020, it is expected that this withdrawal will increase 417 percent for Program A and 488 percent for Program B.

Current (1970) and projected water withdrawal, consumptive use, and return flow for major use categories are presented in Appendix K. By 2020, it is expected that water withdrawals for Program A (and Program B) will increase by 151 percent (187 percent) for municipal supply, 770 percent (927 percent) for industry, and 16 percent (33 percent) for irrigation.

Water Quality

General

Water is variable in two important characteristics: composition and temperature. Both profoundly affect its usefulness.

The composition of water is determined by its content of solids, gases, liquids, and living organisms that occur either in solution or suspension. The kinds and amounts of these constituents depend upon a number of factors. Of particular importance are the chemical composition and solubility of soil, rock, gases, and organic substances that water comes in contact with in the hydrologic cycle. Under most circumstances, constituents which occur naturally in water are vital to the support of plant and animal life. However, natural discharges from such sources as salt springs, and wastewater discharges from municipal, industrial, and agricultural sources often contribute large quantities of pollutants. Spent cooling water that is high in heat energy impairs the usefulness of receiving waters. And, herein lies the concept of water quality, which relates the physical, chemical, biochemical, and bacteriological characteristics of water to its usefulness.

Surface Water

The discussion of water in this section is not directed primarily at defining pollution, but rather at describing "background" quality in terms of the more common water quality parameters such as calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, nitrate, dissolved solids, specific conductance and temperature. Streams are subject to natural variations in quality often reaching the largest differences at high and low flow. Maximum concentrations often occur during low flow conditions, and it is also during this period that waste discharges from pollution sources have their greatest impact on stream quality. Most of the streams in the Lower Mississippi Region have good natural quality with relatively narrow ranges of quality variations.

Waters are often classified in terms of their most prominent anions and cations. Many of the streams in the Lower Mississippi Region contain calcium bicarbonate waters. However, sodium chloride waters are common, particularly during low flow conditions in WRPA 5 and in the lower reaches of coastal zone rivers of WRPA's 9 and 10.

Chemical analyses of water from 39 streams in the Lower Mississippi Region are listed in table 5. Rather than representing the actual composition of an individual or composite sample of water from each river, the numerical values of the water quality parameters in table 5 are maximum values selected from among individual analyses presented in the reports on the 10 water resource planning areas.

The purpose of this method of presentation is to emphasize potential water quality problem areas. The analyses included in the 10 WRPA reports are intended to indicate the largest range in water quality variation at each sampling station that has occurred principally during the last 15 years (1955-1970). Important parameters are dissolved

Table 5 - Stream Quality, Lower Mississippi Region

WRPA	Stream 1/	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH Max.	pH Min.	Dissolved Oxygen Min.	Temp. °C
1	Mississippi River	61	16	168	37	3.6	96	36	3.9	344	538	7.7	6.7	4.0	28
2	St. Francis River	76	17	328	13	2.2	24	8.5	2.2	329	517	8.5	6.2		16
	Right Chute Little River	64	14	254	13	3.9	19	12	3.9	288	432	7.9	6.9		26
	Left Chute Little River	76	17	304	10	1.8	27	4.9	0.1	311	485	8.1		8.4	
	White River	43	20	194	37		6.9	70	1.7	349	544	8.2	7.1		15
	Arkansas River	154	42	121	706	12	134	1,380	2.6	2,810	4,450	7.9	6.8	6.8	21
3	Mayfield Creek	6.6	2.3	34	10	2.8	8.0	7.0	1.8	77	96	6.5			
	South Fk. Deer River	3.2	1.7	15	3.2	1.4	8.2	2.9	2.6	74	52	7.1	6.8		
	North Fk. Deer River	4.7	2.3	22	5.0	1.6	11	4.2	1.4	60	78	7.2	6.6		
	Hatchie River	7.9	1.9	22	10	1.2	8.5	20	2.4	372		7.1	6.7	5.5	25
	Wolf River	3.4	1.2	18	3.8	2.9	4.1	3.2	0.5	79	47	6.5	6.4		
4	Yazoo River	27	7.2	128	19	3.0	10	19	1.4	174	265	7.0	5.8		
	Sunflower River	56	16	277	24	4.6	16	12	3.5	272	478	7.0	6.7		
5	Ouachita River	429	110	99	2,300	36	48	4,660	23	9,310	13,600	7.9	4.4		33
	Smackover Creek	3,730	955	52	21,100	268	5.2	41,400	0.7	73,000	92,000	6.7	6.6		37
	Saline River	21	5.6	82	30	8.3	85	4.5	1.4	186	280	8.0	7.1		27
	Bayou Bartholomew	32	9.7	161	24	3.8	33	55	4.1	270	454	8.4	6.1		19
	Bayou DeLoutre	394	92	208	2,720	30	70	5,000	0.6	8,420	14,300	7.3	5.6		23
	Bayou D'Arbonne	170	23	50	669	4.0	90	1,350	0.8	2,370	4,370	6.8	5.6		23
	Little River	169	98	160	6,450	31	56	10,300	0.8	18,300	30,000	6.9	6.5		20
	Red River	130	38	220	228	5.5	258	388	1.2	1,190	1,930	8.3	7.0		29
6	Boeuf River	95	35	339	83	5.2	87	137	1.0	628	1,060	7.9	6.5		16
	Bayou Macon	73	25	312	52	6.0	25	62	1.5	348	685	8.2	6.7		15
	Tensas River	76	25	404	45	3.4	12	31	0.4	469	711	7.9	6.7		27
7	Big Black River	21	8.2	82	55	3.9	9.4	96	1.9	256	455	7.2	5.7		
	Homochitto River	4.0	1.2	19	12	1.6	3.4	18	0.1	62	91	6.5	6.2		
8	Tangipahoa River	3.2	0.8	16	6.0	2.8	3.2	7.3	1.4	56	54	6.0	5.9		27
	Amite River	16.0	6.1	32	102	8.0	11	181	1.1	371	821	7.0	6.3		28
9	Calcasieu River	10.0	1.5	120	1,050	89.5	203.1	3,425	1.2	155	6,706	7.8	5.8	3.4	33
	Mermentau River	16	19	69	158	11	41.2	254	2.8		1,286	8.0	6.2	1.9	34
	Bayou Nezpique	3.1	1.0	14	5.0	2.2	1.2	6.8	0.5	31	56				14
	Bayou Des Canne	11	3.0	48	21	4.0	8.2	29	0.1	110	212				18
	Bayou Teche	21	7.7	113	158	18.6	80.3	225	1.3	65	1,059	8.5	6.2	2.0	31
	Bayou Boeuf	37	10	115	49	5.3	19	89	1.4		512	7.4			
	Vermilion River	80	202	68	1,640	12.5	405	2,920	1.8		9,444	8.3	6.3	1.0	31
	Atchafalaya River	47	16	159	114	10	81.2	181	3.5		964	8.6	6.9	3.7	33
10	Bayou LaFourche	55	30	235	285	12	73	500	3.4	1,060	1,950	7.3	6.7		
	Bayou Terrebonne	38	31	268	28	8.3	6.4	47	1.8	372	573	7.4	6.7		
	Old Intercoastal Waterway	42	16	135	85	4.2	46	145	8.2	398	751	7.3	6.6		

1/ The analyses in this table are based on maximum numerical values for each parameter listed in the Stream Quality table for each WRPA. Exceptions are as indicated for pH and dissolved oxygen.
All concentrations are in milligrams per liter except specific conductance (micromhos), pH (units) and temperature, (degrees centigrade).

Blackened water denotes poor quality water entering receiving stream.

Poor quality water can result in fish kills in stream.

solids, chloride, sulfate, dissolved oxygen, and temperature. The selection of analyses having maximum and minimum mineral composition at each station is based on dissolved solids (or specific condustance when dissolved solids have not been determined). However, the highest or lowest numerical values for the other parameters do not necessarily occur in the same analysis having the highest or lowest dissolved solids. Analyses with high chloride or sulfate concentrations were occasionally given preference when the dissolved solids concentration of these samples was not necessarily the maximum. Therefore, the maximum listed for each parameter apply only to the analyses included in this appendic in the WRPA summaries.

Natural stream quality is not a constant condition, but varies along the course of a stream and with time. Numerous factors control the natural quality and these include rainfall, overland runoff, ground water seepage, the flow of the stream itself, daily and seasonal temperature variations, seasonal growth and decay of plants and daily and seasonal changes in the photosynthetic processes of plant life in the stream.

Turbidity, color, algae, and dead organic material are the principal natural pollutants in the Lower Mississippi Region. In all the water resource areas of the region, stream quality problems relating to these four parameters are assumed to occur on all the streams at one time or another.

Turbidity, caused by suspended matter, imparts a murky appearance to the water and inhibits light penetration. Common substances that cause turbidity are suspended clay, silt and sand, micro-organisms, and organic debris. Drinking water criteria specify that turbidity should not exceed 5 Jackson units.

Color is caused by the presence of organic and inorganic substances, either in solution or suspension. Decomposition products of dead vegetation, suspended live algae and sand, silt and clay, and compounds of iron and manganese are prime sources of natural color. Drinking water criteria specify that color should not exceed 15 units, based on the platinum-cobalt standard.

Algae (and other small free-floating or attached plants) grow in natural waters in large numbers and in many forms. However, when a stream is rich in nutrients, these promote the massive growth of algae and the development of pond scum or algae blooms on small ponds and sluggish streams.

Dead organic materials cause discoloration of the water and may place a natural biochemical oxygen demand on the stream and thus lower the dissolved oxygen to natural levels that may be less than the 5 mg/l accepted herein as the minimum concentration. Although, this natural

deoxygenation is not thought to be a prevalent condition in the Lower Mississippi Region except on small sluggish streams and certain coastal waters, it must be considered when determining the causes of pollution.

Erosion is the principal cause of natural pollution of streams. It is the result of precipitation and surface runoff. Mechanical erosion involves the physical transport of rock, soil particles, and vegetation to receiving streams, causing turbidity, discoloration, and a load of dead organic matter. Chemical erosion involves the dissolving of organic and inorganic rock and soil material during leaching and flow over the land surface following rainfall. Consisting in part of notrogenous and phosphorous compounds, these nutrients cause eutrophication or nutrient enrichment of streams which promotes algae growth and large daily fluctuations in the dissolved oxygen concentration of receiving streams.

Natural catastrophies such as hurricanes, tornadoes, earthquakes, and flooding may cause extensive pollution problems ranging from bacteriological contamination of water supplies to disruption of sewer systems and damage to sewage treatment facilities.

Streams receiving the largest discharges of wastes in each planning area are listed below:

WRPA	Stream	General Source Area
2	Mississippi River	Helena, Ark,
	Left Hand Chute Little River	Blytheville, Ark.
	Bayou DeView	Jonesboro, Ark.
3	Mississippi River	Memphis, Tenn.
	No. Fork Forked Deer River	Humboldt, Tenn.
	Mississippi River	Wickliffe, Ky.
	So. Fork Forked Deer River	Jackson, Tenn.
	Hatchie River	Bolivar, Tenn.
4	Mississippi River	Vicksburg, Miss.
	Mississippi River	Greenville, Miss.
	Yazoo River	Yazoo City, Miss.
5	Arkansas River	Pine Bluff, Ark.
	Ouachita River	Monroe, La.
	Ouachita River	Camden, Ark.
	Red River	Alexandria, La.
6	Boeuf River	Bastrop, La.

WRPA	Stream	General Source Area
7	Mississippi River	Natchez, La.
8	Mississippi River	Vicinity Baton Rouge Area, La.
	Mississippi River	Vicinity Plaquemine, La.
	Bayou Francois	Gonzales, La.
	Amite River	Denham Springs, La.
	Lake Maurepas	Ponchatoula, La.
	Thompson's Creek	Jackson, La.
	Choctaw Bayou	Port Allen, La.
	Lake Maurepas	Hammond, La.
	Calcasieu River	Lake Charles, La.
	Calcasieu River	Oakdale, La.
9	Calcasieu River	De Ridder, La.
	Vermilion River	Lafayette, La.
	Vermilion River	Breaux Bridge, La.
	Bayou Teche	New Iberia, La.
	Bayou Teche	Jeanerette, La.
	Gulf Intracoastal Waterway	Franklin, La.
10	Mississippi River	New Orleans Area, La.
	Black Bayou	Thibodaux, La.
	Bayou Chauvin	Houma, La.
	Lake Pontchartrain	Metairie Area, La.

Ground Water

The Lower Mississippi Region is underlain by a sequence of rock units that vary in geographic location, thickness, lateral extent, lithology, mineralogic composition, depth below land surface, geologic age, and in water quality characteristics. As indicated in table 6 ground water is obtained from rock units ranging in age from the Quaternary to the Precambrian. The Quaternary and Tertiary units become progressively thicker towards the Gulf of Mexico and towards the central north-south axis of the Lower Mississippi Region, and, in WRPA's 6, 8, 9, and 10, these are the only units from which fresh water supplies are obtained.

Chemical analyses of water from aquifers of various geologic periods in each water resource planning area are listed in table 6. As in the case of table 5, the numerical values are maximums selected from among individual analyses presented in the WRPA summaries, which were selected on the basis of maximum and minimum dissolved solids. However, the occurrence of brackish water high in sodium chloride or sodium bicarbonate may occur locally or

Table 6 - Ground-Water Quality, Lower Mississippi Region

WRPA	Aquifer System 1/	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH Max.	pH Min.	Temp. °C
2	Quaternary	63	17	265	267	0.0	27	400	0.4	930	1,690	7.8	6.0	18
	Tertiary	125	31	610	616	16	44	618	3.2	1,570	3,520	7.8	6.1	27
	Cretaceous	74	22	352	242	15	58	452	1.4	1,120	768	8.0	6.2	31
	Pennsylvanian	39	8.7	210	26	0.8	5.6	9.5	3.0	214	351	8.2	6.3	20
	Ordovician	103	51	427	115	5	24	246	22	751		7.7	6.8	
	Cambrian	464	38	299	329	1.4	1,100	467	9.0	1,990		8.4	7.0	
	PreCambrian	34	18	174	7.7	0.0	6.9	6.3	0.1	177		8.0	6.3	
3	Quaternary	165	43	715	30	27	257	33	13	707	1,110	8.4	5.9	20
	Pliocene-Pleistocene	7	2.2	644	11	0.9	136	354	27	1,380	2,140	7.4	6.3	16
	Tertiary	74	80	644	165	58	652	50	72	1,060	1,210	8.2	3.9	19
	Cretaceous	152	19	925	432.2	2.6	75	38	1.2	1,026	761	8.2	5.8	29
	Paleozoic	36	9.6	141	77	8.5	15	125	0.3	358	358	7.6		
4	Quaternary	174	16	879	143	0.3	46	58	12	883	416	7.6	-	18
	Tertiary	74	15	1,552	1,000	17	29	1,170	17	2,700	4,610	8.9	5.7	34
	Cretaceous	46	11	566	412	10	15	418	2.4	1,070	1,890	8.5	7.6	24
5	Quaternary	94	39	536	243	35	46	298	100	973	1,750	7.4	5.7	19
	Tertiary	341	206	716	1,050	16	2,210	1,360	15	3,370	4,680	8.4	3.6	22
	Cretaceous	54	12	140	23	3.3	92	16	0.6	456	325	6.9		18
	Pennsylvania	51	11	189	26	0.8	7.8	47		278	473	7.7	6.3	18
	Mississippian	15	11	158	30	2.8	3.4	12	21	169	290	8.1	8.0	20
	Devonian	20	4.8	112	15	3.6	12	2.5	0.2	146	114	8.0		22
	Ordovician	62	11	302	48	15	45	22	0.6	337	568	7.7	7.5	19
6	Quaternary	144	60	599	192	4.9	264	291	2.2	1,040	1,910	7.9	7.1	19
	Tertiary	49	15	457	470	13	12	462	1.5	1,190	2,200	8.5	7.0	26
7	Quaternary	82	46	488	17	2.5	10	29	0.7	415	682	8.0	7.6	
	Tertiary	46	33	3,110	3,490	24	51	707	40	15,200	9,950	8.5	5.4	29
	Cretaceous	20	3.2	638	394	6.0	10	378	1.5	1,070	1,780	8.1	7.2	3
8	Quaternary	53	13	251	11	1.8	0.0	5.2	2.5	232	396	7.6		
	Tertiary	16	2.9	279	238	1.1	13	193	1.1	604	1,090	8.7	6.4	33
9	Quaternary	1.3	0.2	193	93	0.4	13	2.7	0.0	243	377	8.6		
	Tertiary	74	42	521	401	1.7	23	470	2.0	1,150	2,030	8.9	6.4	31
10	Quaternary	24	11	508	347	3.5	0.2	308	3.2	971	1,740	8.0		21
	Tertiary	1.9	0.1	238	97	1.1	13	4.7	0.3	256	399	8.2	8.0	

1/ The analyses in this table are based on maximum numerical values for each parameter listed the Ground-Water Quality table for each WRPA. Exceptions are as indicated for pH.
All concentrations are in milligrams per liter except specific conductance (micromhos), pH (units) and temperature (degrees centigrade).

regionally in areas of mappable size in these freshwater aquifers. The maximum concentration among the analyses included in the planning area reports are in the Tertiary rocks (Sparta Sand of WRPA 7) with 3,490 mg/l sodium and 3,110 mg/l bicarbonate. Ground water high in sodium chloride occurs in rocks of Tertiary age in WRPA's 4 and 5. High sulfate waters occur locally in the Cambrian rocks of WRPA 2 and in Tertiary rocks of WRPA's 3 and 5.

In years past, ground water has generally had the reputation of being uncontaminated by bacteria or chemicals. In fact, ground water has had such a distinguished reputation that even today there are locations where ground water, issuing as springs, is thought by some to have therapeutic properties. But even in past years, there were occasional reports of "poisoned" wells, and from the middle and toward the end of the nineteenth century, a number of dangerous diseases, including cholera and typhoid fever, became associated with drinking water drawn from wells as well as from surface supplies. Many aquifers yield highly mineralized natural waters unsuitable for drinking.

Pollution of ground water that is attributable to the activities of man is not prevalent in the Lower Mississippi Region. Soil and rock formations tend to act as natural filters and suspended and colloidal materials are generally removed in seepage to the water table. However, dissolved substances that do percolate through to the zones of saturation are none the less troublesome. Although pollution of ground water may be localized and spreads slowly, both laterally and vertically in an aquifer, it can be permanent by human time standards and costly to control or abate. For these reasons, ground water pollution, although unseen, slow and generally unspectacular, is more insidious, because it is generally well established before detection.

Under the ever increasing urban, suburban, industrial and agricultural development that is occurring nationwide, quality problems relating to ground water pollution are now emerging. Determining where such pollution is occurring is difficult and costly because in a literal sense the problem is under foot and out of sight.

The occurrence of man made pollution of ground water in the Lower Mississippi Region is reported in a recent unpublished study by the U.S. Geological Survey (4). The discussion that follows is based almost exclusively on data obtained as part of that nationwide inventory of ground water pollution by the Geological Survey.

Of the 35 occurrences of ground water pollution presented in the reports on each of the water resource planning areas, probably all except two are caused by man. The disposal of oil field brines has

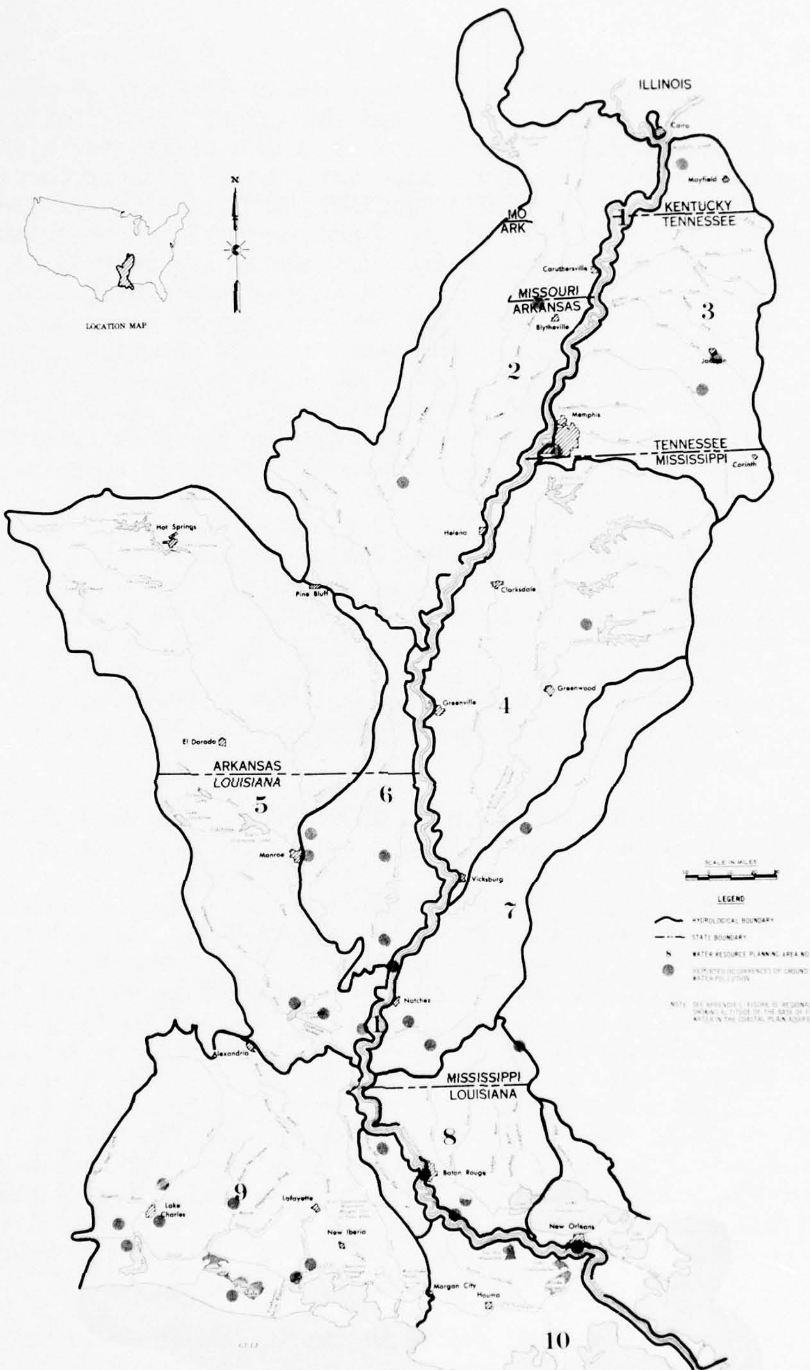
caused the most numerous problems in the present listing. Because of the slow movement of ground water and the rather persistent nature of ground water pollution, older practices such as saltwater disposal pits have caused problems that are apparently still present locally. Accidental injection into a shallow aquifer, and pollution of fresh water zones in the process of oil field pressurization with saltwater are also involved. Heavy pumping from freshwater aquifers is also numerous among the 35 occurrences. Such pumpage has caused contamination by coning up of saltwater in aquifers underlying the pumped well, landward migration of the freshwater and saltwater interface in the Gulf coastal areas and possible lateral movement of relatively localized saltwater zones into the freshwater areas of the aquifer. Another type of occurrence is the escape of saltwater or gas into freshwater aquifers through improper well construction or improper plugging of abandoned wells.

Rare forms of ground water pollution in the Lower Mississippi Region involve the discharge of sewage, the cutting of a clay river bottom permitting salt river water to infiltrate the underlying aquifer, a deep gas blowout presumably polluting some freshwater aquifers, the dumping of poultry plant wastes, the disposal of pickle plant brine and liquid wates containing hydrgen cyanide from a pottery plant, leakage from a gasoline storage tank at a service station, and buried perticide wastes.

Figure 2 shows sites of reported occurrences of ground water pollution discussed in the water resource planning area summaries.

Ground waters are considered to be naturally polluted when they contain mineral concentrations exceeding the criteria established for the various water uses. Common constituents of ground water that may cause problems in drinking water and water used for laundering are iron, manganese, calcium, magnesium, sulfate, and chloride. Drinking water standards recommend concentrations of iron and manganese not to exceed 0.3 and 0.05 mg/l respectively, to avoid taste and staining problems. Calcium and magnesium are the principal ions that cause hard water which leads to increased soap consumption and the need for synthetic detergents. To avoid the laxative effects of high sulfate waters, a recommended maximum of 250 mg/l is specified for drinking water. Chloride concentrations should not exceed 250 mg/l to avoid water having a salty taste. Criteria for public water supplies are discussed in the section on "Water Quality Criteria."

Soil and rock are natural filtering media, and it would be a rare occurrence for ground water to be naturally polluted with bacteria. No such condition is known to exist in the Lower Mississippi Region.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

AREAS OF GROUND-WATER POLLUTION

FIGURE 2

Existing Water Quality Management Programs

State Programs

Louisiana. The Division of Water Pollution Control of the Louisiana Wildlife and Fisheries Commission and the Bureau of Environmental Health, Louisiana State Health Department, are the two primary state agencies in Louisiana with ongoing water quality management programs. Considering the combined efforts of both agencies, about 50 man years were expended each year in fiscal years 1972 and 1973 on water pollution control. The total state budgets for water pollution control for fiscal years 1972 and 1973 were $705,713 and $720,833, respectively.

The Division of Water Pollution Control is the administrative arm of the Louisiana Stream Control Commission, which presently issues industrial discharge permits and establishes rules and regulations for enforcing the state water pollution control laws. The commission periodically revises and facilitates implementation and maintenance of state stream standards.

Ongoing programs of the Division of Water Pollution Control (DWPC) include stream and effluent monitoring, compliance reviews of industrial permits and plant inspections, laboratory analysis of water samples, river basin and state program planning, and initiation of enforcement actions against polluters where necessary.

The Bureau of Environmental Health is responsible under state health codes for controlling municipal sewage. During fiscal year 1973, the bureau, in cooperation with the Division of Pollution Control, supervised the formulation of water quality management plans for Lake Pontchartrain, the Lower Mississippi River (below Old River) and Barataria Bay. During fiscal year 1972, the bureau completed a similar plan for the Red River.

The bureau has ongoing programs for training of municipal sewage treatment plant operators, municipal plant operation and maintenance inspection and monitoring, and review and certification of plans for construction of municipal collection and treatment projects.

The bureau and DWPC have established a Waterworks Warning Network on the Lower Mississippi River for safeguarding municipal water supply intakes against hazardous materials discharged into the river. In addition, the division has adopted a state contingency plan for the remainder of the state for reporting and investigating spills of oil and other hazardous materials.

In addition to the two primary water pollution control agencies, the Governor's Council on Environmental Quality coordinates the activities of state agencies involved in water pollution control and

other environmental programs.

Areas in Louisiana encompassed in the Lower Mississippi Region that are non-compliant with adopted state stream standards (and, therefore, high priority areas for water quality management activities) are as follows:

Calcasieu River	- Lake Charles to Gulf of Mexico
Vermilion River	- Lafayette to river mouth
Bayou Teche	- Breaux Bridge to Charenton
Mississippi River	- Baton Rouge to below New Orleans
Ouachita River	- State line to below Monroe

Arkansas. The Department of Pollution Control and Ecology is the state agency responsible for the water quality management program in Arkansas. In fiscal years 1972 and 1973, the department expended approximately 39 man-years on water pollution control activities. The total budgets for water pollution control for fiscal years 1972 and 1973 were approximately $472,000 and $566,000, respectively.

Activities of the department in 1972 centered on implementation of a mandatory municipal sewage treatment plant operator certification system including inventory and classification of 229 municipal sewage treatment plants throughout the state, completion of 15 plants, pesticide monitoring and water quality stream surveys in the Upper Arkansas and Upper White River Basins.

Ongoing programs of the department include a permit issuance program for all point dischargers, municipal sewage treatment plant operator training, a statewide water quality monitoring network, data collection and analysis, surveillance and enforcement activities associated with industries, municipalities, oil field operations, etc., and river basin water quality management planning.

The following priorities have been assigned by the state for completing river basin (water quality) management plans for those areas located in the Lower Mississippi Region.

1. White River Basin
2. Arkansas River Basin
3. St. Francis River Basin
4. Ouachita River Basin

Metropolitan and regional water quality management planning is being conducted by the Mississippi-Arkansas-Tennessee Council of Governments (West Memphis SMSA), the Southeast Arkansas Regional Planning Commission (Pine Bluff SMSA), and the Metropolitan Council of Governments (Little Rock-North Little Rock SMSA).

Mississippi. The Mississippi Air and Water Pollution Control Commission is the state agency responsible for the water quality management program in Mississippi.

The commission has ongoing programs in issuing permits to point dischargers, initiating enforcement actions against violators of water quality standards, supporting municipal sewage treatment plant construction, and conducts water quality monitoring and surveillance, plant operator training, laboratory analysis, and river basin (water quality) management planning. Although the commission is designated as the certifying agency for basin and metropolitan/regional water quality management plans in Mississippi, the planning activities are carried on by several other agencies and entities within the state with overview by the commission.

In the state of Mississippi, the river basins included in the Lower Mississippi Region are the Yazoo and Big Black Rivers, and the South and North Independent Streams. The North Central Mississippi Planning and Development District is designated to complete water quality management plans for the Yazoo, Big Black and North Independent Streams Basins. The plan for the South Independent Streams Basin is being prepared by the Southwest Mississippi Planning and Development District. The Mississippi-Arkansas-Tennessee Council of Governments is currently developing a metropolitan/regional management plan that includes DeSoto County, Mississippi.

Tennessee. The Tennessee Water Quality Control Board has regulatory responsibility for water quality management. The Division of Water Quality Control in the State Health Department administers the state water quality management program for the board. During fiscal years 1972 and 1973, the division expended 51 and 69 man-years on water pollution control throughout the state with total budget expenditures of $1,020,950 and $1,094,700.

The Division of Water Quality Control has a planning section and is developing basin plans throughout Tennessee.

Ongoing programs of the division are stream monitoring, sewage treatment plant inspections, operator training, laboratory analysis, enforcement and municipal sewage treatment grant application review. The program includes municipal, industrial, agricultural and other pollution sources. In the area of water quality standards, the

division, in cooperation with the State Game and Fish Commission, is developing a list of Tennessee streams which should be protected for cool water species of fish and aquatic life.

The permit program in Tennessee was revised in fiscal year 1972 as the result of the enactment of the Water Quality Control Act of 1971. The major objective is to prevent pollution by controls at the discharge points by permits specifying effluent limitations and an effluent quality monitoring program.

Missouri and Kentucky. Missouri and Kentucky have state water quality management programs administered by agencies similar to those previously discussed.

Federal Programs

Environmental Protection Agency. The Environmental Protection Agency assists all states in the Lower Mississippi Region with the preparation of water quality management programs through program grants to the state water pollution control agencies, construction grants for municipal sewage treatment plants, operator training grants administered through state agencies, research grants, and technical and other assistance.

The Environmental Protection Agency has a water quality monitoring network on interstate waters. Monitoring stations are located mainly at state lines. A system of water quality data analysis and retrieval (STORET) is made available automated and at no cost to government entities with ongoing water quality management programs. In addition, the Environmental Protection Agency has a field office and laboratory located near Slidell, Louisiana, that provides assistance in monitoring surveys and laboratory analysis. At the request of the Louisiana Stream Control Commission, the Environmental Protection Agency recently completed a 3-year investigation of industrial pollution of the Lower Mississippi River in Louisiana from Baton Rouge to the river mouth. During and as a result of this investigation, improvements in the quality of the industrial waste discharges have been observed and are expected to improve substantially within the next 2 to 3 years as ongoing abatement programs are developed and completed.

U.S. Army Corps of Engineers. The Corps of Engineers is currently initiating two studies under their urban studies program. One study will involve the New Orleans-Baton Rouge metropolitan area and the other involves the Pine Bluff area in Arkansas. The studies represent a water resources planning effort with particular emphasis on water supply and pollution problems and waste water and stormwater drainage management. The studies currently require an effort sharing of 75 percent Federal and 25 percent non-Federal for the waste water management portion.

U. S. Geological Survey. The USGS, with District offices in each State, operates water quality monitoring networks on inter and intra State streams, usually in cooperation with one or more State agencies. Data is published annually, by States, in USGS Basic Data Releases, as well as being available from computer storage.

U. S. Department of Agriculture. Agencies of the Department such as the Farmers Home Administration, Agricultural Stabilization and Conservation Service, and Soil Conservation Service have programs which contribute to water quality management. These programs consist of sewer community projects, controlling of agricultural organic waste with holding ponds, disposal lagoons, and land spreading, and studies of river basins and small watersheds which offer additional opportunities for exploring solutions to agricultural pollution problems.

Present Waste Treatment

Methods

Pollution control involves methods of wastewater treatment and disposal which, when effectively employed, protect receiving waters from being polluted and thereby becoming unsuitable for specified beneficial uses. The applicability of methods are generally related to the three major sources of wastewater: municipal, industrial, and agricultural.

Municipal (domestic and commercial) sewage treatment employs five principal methods, each involving a number of mechanical, biological, and chemical processes:

Primary Treatment. Removal or size reduction of larger floating solids to protect pumps and facilitate other treatment processes, and removal of heavy solids and excessive quantities of oil and grease. This is accomplished by screens, comminuters, grit chambers, and pre-aeration tanks.

The further removal or reduction of settleable solids and about 35 percent of the suspended solids is accomplished by sedimentation in settling tanks. When chemicals are used to promote settling or separation, chemical feed units, mixing devices, and flocculators are used.

Primary treatment, measured in terms of BOD reduction, is approximately 35 percent effective when treatment plants are properly designed and operated for maximum efficiency.

Secondary Treatment. Follows primary treatment and involves biochemical decomposition of organic substances to inorganic or stable organic products. This is accomplished by trickling filters, secondary

clarifers, aeration tanks, intermittent sand filters, and stabilization ponds.

Secondary treatment, measured in terms of BOD reduction, is approximately 85 percent effective when treatment plants are properly designed and operated for maximum efficiency.

Chlorination. Applied, in all stages of sewage treatment, to either prevent sewage decoposition to avoid odors and protect plant structures, to aid sedimentation, trickling filter operation and activated sludge bulking, delay biochemical oxygen demand, and disinfection of sewage.

Sludge Treatment. Removal of water and organic decomposition of sludge (the fine solids removed in primary and secondary treatment) to inorganic solids or stable organic solids. This is accomplished by incineration.

Advanced Treatment. Reduction of phosphorus and nitrogenous compounds, accomplished by chemical treatment, ion exchange, reverse osmosis, and electrodialysis, and removal of residual organics, taste, and odor by carbon absorption, follows secondary treatment.

Advanced waste treatment, measured in terms of BOD reduction, is approximately 98 percent effective when treatment plants are properly designed and operated fro maximum efficiency.

Disposal of treated municipal sewage is accomplished by three methods:

Dilution. Discharge of sewage to a surface water.

Irrigation. Spreading of treated sewage over land surface through ditches or by sprinkler systems.

Subsurface Disposal. Use of pits, tile fields, and injection wells for disposal into the ground.

Mechanical Reaeration. Stationary or rotating air injection and diffusion systems for sludge treatment and in-stream reoxygenation. Where critical deficiencies in dissolved oxygen occur, such as a reach of stream with a heavy biochemical oxygen demand, mechanical reaeration can be applied, but is normally considered a temporary measure or last resort.

Industrial wastewaters are highly variable in composition from one industrial category to another, among individual industries in each category, and among industries producing the same products. Treatment is equally complex. To generalize on treatment methods is

to oversimplify. However, many industrial wastewaters contain suspended solids, settleable solids, BOD wastes, and coliform bacteria.

A number of industries also produce toxic materials, excessive oil and grease, liquids with high or low pH, relatively small but highly concentrated baths, turbidity, brines, foam, phenols, dyes, high ammonia concentrations, thermal waste waters in large quantities, or substances such as sulfite waste liquors, pickling liquors, heavy metals, iron, and a myriad of organic and inorganic compounds. Pretreatment or separate treatment is required before release either to a municipal sewage treatment plant or before disposal to a receiving surface water.

Treatment of industrial waste waters includes a wide variety of methods that range, for example, from those conventionally applied to municipal sewage to effluent component recovery techniques. At this time, available information on specific industrial waste components and methods of waste treatment used by industries located in the Lower Mississippi Region is inadequate for detailed discussion. However, several of the more important industrial waste treatment methods that are used in the region are briefly discussed in general terms in the following paragraphs.

Effluent Component Recovery. The use of this method depends on economic considerations and the necessity to comply with requirements of pollution abatement. Included in this management technique, which is applied in some instances in the Baton Rouge, Louisiana, area, is the removal of usable or saleable by-products which were previously discharged as pollutants suspended or dissolved in the wastewaters. The economic value of the recovered by-products often offsets a portion of the total cost of wastewater treatment for pollution control.

Examples of effluent component recovery are to be found within the metals industry where ion exchangers are used to recover phosphoric acid, nickel, and chromium from plating solutions, and in paper mills where sulfite waste liquor is used as fuel, road binder, cattle fodder, and fertilizer.

Lagooning. Lagoons are used relatively infrequently by industry in the region, but more commonly by smaller communities as oxidation ponds for BOD reduction.

Incineration. Although this method has been used extensively in solid waste disposal, direct flame combustion can be applied to liquid wastes that are either flammable or contain combustibles. Wastewaters are sent through settling chambers and flocculators to increase the concentration of the solid constituents. This more concentrated liquid is then passed through filter beds of vacuum filters for water removal. The filter cake is then fed into an incinerator for combustion.

This method is used, for example, in such industries as oil refineries (for disposal of oil and grease wastes), in paper mill operation (combustible fibers and "white water") and in the chemical industry (for the disposal of cyanide wastes). Use of incineration often results in air pollution problems, which can be just as detrimental environmentally as the original pollutant and, consequently, incineration is used only to a very limited extent in the Lower Mississippi Region.

Injection Wells. This method has been used for decades in disposing of oil field brines. However, use of this disposal method for other potential pollutants is a relatively new technique, and it is estimated that less than 20 injection wells were in existence in the Lower Mississippi Region in 1970. Pretreatment may be required to avoid well plugging and corrosion. Chemical compatibility between the injected waste waters and the aquifer may have to be determined to avoid precipitates that could plug the aquifer and reduce or prevent injection.

Difference in water color clearly shows the amount of treatment. The contents of the bottles beginning at the left are as follows: raw sewage, primary treatment effluent, activated sludge treatment effluent, separate bed treatment effluent, and carbon column treatment effluent.

Cooling Towers and Cooling Ponds. Structures of various design and operation used for heat dissipation to the atmosphere from condensed steam or heated cooling water for recirculation or disposal are used extensively throughout the Lower Mississippi Region. However, due to an abundance of water in the region, it is nearly always more economical to use once through cooling water which is discharged directly into a large lake or flowing stream and most industries with large cooling water requirements tend to locate near water supplies which will allow the use of this method.

Agricultural associated pollution caused by pesticide and fertilizer use is not amenable to treatment since these are almost exclusively non-point sources. The problem, however, may be alleviated by selective use of existing perticides and research and development of new pesticides. Curbing of excessive fertilizer use can be best achieved by producer education-information programs. Present animal waste management systems are being utilized with proven soil and water conservation practices, such as diversions, holding ponds and tanks, land spreading, and disposal lagoons. Sediment and erosion associated pollution of surface waters can be greatly reduced by land treatment programs such as terracing, improved tillage practices, and others described in the Sediment and Erosion Appendix.

Bacterial control in water is accomplished by disinfection which may be obtained by several methods, including introduction of one of the following:

(1) Chlorine
(2) Iodine
(3) Bromine
(4) Ozone
(5) Potassium Permanganate
(6) Hydrogen Peroxide
(7) Heat
(8) Light
(9) Metal Ions
(10) Alkalis and Acids
(11) Surface-Active Chemicals

At the present time, chlorination is the only method used extensively throughout the region.

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

There are three major sources of organic waste production: municipal, industrial, and agricultural. The daily wastes generated from municipal and industrial sources are summarized in table 7, while those waste loads accruing from agricultural sources are shown in table 8. The agricultural waste production should not be directly equated to the municipal and industrial production when assessing pollution problems since municipal and industrial wastes result in concentrated point source loads whereas most agricultural wastes are widely dispersed and generally do not enter the Lower Mississippi Region's water supplies en masse.

Organic waste production is defined in terms of pounds of 5-day Biochemical Oxygen Demand and in terms of population equivalents for municipal and industrial wastes. These wastes are complex in physical, chemical, and biochemical composition, and biochemical oxygen demand is but one of many water quality parameters that may adversely affect the quality of receiving waters. However, the calculation of waste loads in terms of biochemical oxygen demand and population equivalents are important because they provide a basis for the framework program and for comparison of present and future pollution loads within and between each of the 10 WRPA's in the Lower Mississippi Region and for comparison between the several national framework studies. More detailed discussion of each category of waste is given in succeeding paragraphs.

Table 7 - Municipal and Industrial Organic Waste Production, Lower Mississippi Region

Category	Daily Raw Organic Waste Production				
	1970	Program	1980	2000	2020
Municipal					
P.E. 1/	3,640,900	A	4,091,800	5,371,500	7,222,700
		B	4,422,600	6,049,900	8,229,100
#BOD 2/	658,450	A	782,760	1,081,420	1,453,940
		B	846,070	1,257,980	1,656,080
Industrial					
P.E.	16,351,400	A	20,256,200	34,480,500	67,257,100
		B	22,217,100	39,964,400	77,593,900
#BOD	2,943,270	A	3,848,690	6,896,100	13,451,450
		B	4,221,260	7,992,870	15,518,790
Total Municipal & Industrial					
P.E.	19,992,300	A	24,348,000	39,854,000	74,479,800
		B	26,639,700	46,014,300	85,823,000
#BOD	3.601,720	A	4,631,450	7,977,520	14,905,390
		B	5,067,330	9,250,850	17,174,870

1/ P.E. - Population equivalents: See Methodology.
2/ #BOD - Pounds of 5-day biochemical oxygen demand.

Table 8 - Agricultural Organic Wastes from Livestock and Poultry, Lower Mississippi Region

		Daily Organic Waste Production (#BOD)		
1970	Program	1980	2000	2020
5,481,880	A	6,814,870	9,106,570	12,115,880
	B	6,814,870	9,772,450	13,010,550

Municipal

In the Lower Mississippi Region in 1970, there were 315 sewered communities of 1,000 or more inhabitants. The total population served by sewer systems was 3,640,900, as indicated in table 9. The total daily raw waste production was 658,450 pounds of BOD_5. According to Programs A and B, the equivalent sewered population is expected to be 7,222,700 and 8,229,100 by 2020, which are increases of 97 and 125 percent, respectively. Correspondingly, the total raw BOD waste production will increase to 1,453,940 pounds per day by 2020 for Program A and to 1,656,080 for Program B.

Sewage contains fecal solids, human liquid wastes, high bacteria concentrations, paper, garbage, detergents, and other disposed materials. Consisting of mostly water, sewage contains solids in quantities of generally less than 0.1 percent by weight. However, the treatment of this small amount, to avoid pollution, causes the major problem in obtaining effluents of adequate quality for disposal to receiving waters. The water portion of the sewage acts as a vehicle for transporting wastes to treatment facilities and from treatment facilities to receiving waters.

Many of the sewered communities discharge their effluent to small streams that seasonally have little or no flow. As a consequence, even secondary treatment of sewage may be inadequate and local water quality problems may arise.

Of the 315 sewered communities of 1,000 or more inhabitants, there are 198 (63 percent of the regional total) that have less than 5,000 inhabitants. The total sewered population of these smaller communities is 467,900, or 13 percent of the regional total. Their average raw waste production, per community, is 425 pounds of BOD_5 per day. Fifty-five communities (17 percent) are in the range of 5,000 to 9,900 inhabitants and have a total sewered population of 387,000 or 11 percent of the regional total. The average raw waste production, per community, is 1,275 pounds of BOD_5 per day. Fifty-four communities (17 percent) range from 10,000 to 49,900 or 28 percent of the regional

total. Their average raw waste production, per community, is 3,355 pounds of BOD_5 per day. There are four communities each in the ranges of 50,000 to 99,900 and 100,000 or more inhabitants. These two ranges comprise sewered populations of 260,700 and 1,518,800, respectively. Their average raw waste productions are 11,732 and 68,346 pounds of BOD_5 per day.

The total production in 1970 of municipal (domestic and commercial) organic wastes in each of the water resource planning areas, expressed in population equivalents (P.E.) listed in table 9 provide a quick comparison of the relative distribution of the municipal organic waste loading in the region.

Table 9 - Production of Municipal Organic Waste, Lower Mississippi Region

WRPA	Gross Municipal Organic Waste Production (P.E.) 1970
10	998,300
3	879,700
9	448,800
5	385,100
2	283,400
8	259,000
4	258,200
6	80,200
7	48,200
1	-
Regional Total:	3,640,900

Industrial

One thousand fifty-nine industries in the Lower Mississippi Region are known to produce biodegradable wastes. Major industrial categories involved in this waste production are food and kindred products (56 percent of the total number of industries inventories), chemical and allied products (25 percent), paper and allied products (10 percent), petroleum and coal products (6 percent), and lumber and wood products (1 percent).

The total production in 1970 of industrial organic wastes in each of the water resource planning areas, expressed in population equivalents (P.E.), are listed in table 10 in order of decreasing quantities.

Table 10 - Production of Industrial Organic Waste, Lower Mississippi Region

WRPA	Gross Industrial Organic Waste Production (P.E.) 1970
5	4,609,900
10	2,921,100
9	2,251,500
8	1,987,800
3	1,944,300
7	989,000
6	925,000
4	517,600
2	205,100
1	-
Regional Total	16,351,300 1/

1/ Minor discrepancy with total indicated in table 7 is due to rounding.

As shown in table 10, the population equivalent for 1970 was 16,351,300. By the year 2020, it is expected to increase to 67,257,100 and 77,593,900 according to Programs A and B, respectively. The corresponding raw BOD waste production before treatment of 2,943,270 pounds per day in 1970 is projected to be 13,451,450 pounds per day by 2020 for Program A and to 15,518,790 for Program B (see table 7.

Agricultural

The production of agricultural organic wastes is primarily associated with the biologic wastes from livestock and poultry. As indicated in table 3, livestock includes four categories: cattle and calves, milk cows, hogs and pigs, and sheep and lambs. Cattle and calves, the largest category in this group, totaled 3,860,500 animals in 1970 and is expected to increase by 2020 to 8,888,600 and 9,545,100 animals according to Programs A and B, respectively. Poultry includes three categories: chickens, broilers, and turkeys. Broilers are the largest poultry category and totaled 89,530,600 fowl in 1970. By 2020, this category is expected to increase to 234,077,800 and 251,371,400 for Programs A and B, respectively.

The total daily raw organic waste produced by livestock and poultry in 1970 and estimated for the projected years is shown in table 8. Table 11 contains data which illustrates the present distribution by WRPA of these wastes. WRPA's 3, 4, and 5 have the most significant portions of the total production, while WRPA 10 has only a small segment of the total.

Table 11 - Production of Agricultural Organic Waste, Lower Mississippi Region

WRPA	Gross Organic Waste Production (# BOD_5) 1970
5	1,060,000
4	894,000
3	824,000
9	682,000
2	577,000
8	522,000
7	462,000
6	370,000
10	91,000
Total	5,482,000

Non-Organic Wastes

Municipal

Municipal (domestic and commercial) sewage consists of 99.9 percent or more of water and 0.1 percent of waste substances that create the need for sewage treatment. This small percentage of material, occurring in solution or suspension in the water, consists generally of about 42 percent mineral solids and 58 percent organic solids.

The non-organic mineral solids that contribute significantly to pollution are the nitrogen and phosphorous compounds. These compounds, though only a very small percentage of total pollutants in terms of weight, nonetheless are the major contributor to nutrient enrichment of receiving waters. Nutrient enrichment in turn causes excessive algae growth which results in relatively wide fluctuations in dissolved oxygen concentrations and eutrophication is accelerated as a consequence.

There are no communities in the Lower Mississippi Region that are known to have combined sanitary and storm sewers, except in older portions of New Orleans. Where such sewerage systems exist, the total strength of the combined sewage is on the average approximately 1.4 times that of the sanitary sewage.

Industrial

Heavy metals such as arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc are used in a variety of manufacturing processes and products. For example, arsenic is used in glassware and ceramics, in tanneries, in dye manufacture, in chemical industries, in compounds for therapy, and as a wood preservative and pesticide. Mercury is being replaced with other substances, but it used in power generation, in the manufacture of lamps, in medical products, disinfectants, pigments, and as a catalyst.

Nutrients, such as nitrite, nitrate, and phosphorous are used in meat packing, shrimp and oyster processing plants, menhaden reduction plants, and sugar factories, in the manufacturing of fertilizers, and in oil refineries.

Toxics include ammonia, cyanides, and pesticides. Ammonia is accociated with meat, poultry, and fish industries, especially menhaden reduction. Rinsing of fruits and vegetables in preparation for canning often gives rise to wastewaters containing pesticides. Chemical industries, oil refineries, and fertilizer manufacturing plants can also be sources of toxic materials.

Most all industries produce wastewaters that cause odors. Meat, poultry, and fish rendering plants, sugar factory stabilization ponds, chemical and petrochemical plants, and paper mills present particularly difficult problems.

Color is caused by suspended solids or substances in solution. Of particular importance as sources are paper mills, meat and fish processing, and vegetable canning plants. Certain chemical industries generate wastewater high in color concentration.

Oil and grease are often founds in the wastewaters of industries because of their use in lubrication of machinery. Oil refineries and

cooking oil refineries (cotton seed, soybean, and fish oil) and some chemical industries are potential large sources of oil and grease.

Accidental discharges of pollutants are not uncommon in industry. Many are minor, but nonetheless vexing in the overall effort to control water pollution. Dramatic events within the Lower Mississippi Region in the last 15 years include massive fish kills in the Mississippi and Atchafalaya River Basins in the early 1960's caused by industrial discharges of pesticides wastes and the large oil fire 7 miles off the Gulf Coast of Louisiana in 1970-1971. A potentially serious accident occurred on the Atchafalaya River near Morgan City, Louisiana, in January 1973 when a barge hauling chlorine struck a bridge causing a span to collapse onto the barge. The barge was sunk, but its load was successfully recovered.

Thermal wastewaters are associated with sugar refineries, canning plants, fish processing plants and in steam electric power generation.

As alluded to above, industrial wastewaters in the Lower Mississippi Region, as a group, are extremely complex. Hundreds of water quality parameters are available for study and the total number can be expected to increase as new materials and processes are developed in the continuing manufacture of products. Industries requiring large water supplies and generating heavy loads of polluting substances are generally numerous throughout the Lower Mississippi Region and prolific adjacent to the Mississippi River in the reach between Raton Rouge and New Orleans, Louisiana. More detail concerning this industrial complex can be found in the WRPA 1 section to this report. Other than a report entitled "Industrial Pollution of the Lower Mississippi River in Louisiana" by the Environmental Protection Agency related specifically to the petrochemical complex in and below Baton Rouge, there exists a severe lack of detailed information on the composition of industrial waste waters as well as the condition and capability of receiving streams throughout the Lower Mississippi Region. The discharge permit program shows promise and is daily accumulating valuable data regarding industrial discharges. A need exists to supplement this program with a water quality monitoring program and to integrate industrial waste considerations into the regional water quality management program.

Agricultural

Sedimentation and erosion are discussed in detail in Appendix S. Land use and management practices are major factors of sediment and erosion rates. In the Lower Mississippi Region, the land affected by erosion in 1970 was 33.7 percent of the region's total and ranges from 65.3 percent in WRPA 7 to 3.7 percent in WRPA 10. The average gross erosion of affected areas is 6.9 tons per acre/year and ranges from 13.3 in WRPA 3 to 1.7 tons per acre/year in WRPA 5.

The use of fertilizers on extensive tracts of cultivated land is a significant potential source of nutrients that can be lost by runoff and wind and carried to the streams. Little information is available on this loss of fertilizers; however, it would appear that 10 percent may be a realistic estimate. In 1969, the use of fertilizers in the Lower Mississippi Region totaled 1,805,007 tons, which were applied to 12,659,529 acres. This averages 285 pounds of commercially mixed fertilizer per acre per year.

Pesticides are used extensively in the Lower Mississippi Region, primarily in the form of insecticides and herbicides applied to crops and croplands. Another significant agricultural use is the application of various insecticides for the control of livestock pests, either by direct treatment of animals or spraying of forage crops. Pesticides are also used on a more localized basis, both for insect and rodent control in livestock and poultry confinement areas and near grain storage areas.

The most common and greatest single use of herbicides in the Lower Mississippi Region is for weed control in row crops. Herbicides are also used to maintain the hydraulic capacity of streams and drainage channels and to control plant growth in navigation channels. Data on the amount of pesticides used in the region are not currently available. Obviously, a large volume of herbicides are used because of the intense agricultural activity in the region. For example, there were about 15 million acres of harvested cropland in the region in 1970, most of which had applications of both insecticides and herbicides. While it is recognized that the use of pesticides is essential to the production of food and fiber, it is also recognized that the indiscriminate use, misuse, mishandling, and accidental spillage of these compounds are a significant source of pollution, which may result from introducing toxic substances into the region's waters - sometimes to the extent that the waters are dangerous to wildlife, livestock, and humans. Use of some of the long-life, highly stable pesticide compounds can accumulate in segments of both wild and domesticated food chains, eventually injuring fish and wildlife and contaminating agricultural foodstuffs, such as beef, poultry, and milk, destined for human consumption. Pesticides have been known to directly injure farm laborers, either through inhalation or contact with the skin.

The excrements of livestock and poultry are potential sources of nutrients such as compounds of nitrogen, phosphorus, and potassium. For example, fresh manure, per 1,000 pounds of animal weight, contains 0.38 pounds of nitrogen, 0.07 pounds of phosphorus, and 0.25 pounds of potassium from dairy cows and 0.94 pounds of nitrogen, 0.25 pounds of phosphorus, and .33 pounds of potassium for poultry (17). Runoff, particularly from cattle feed lots, and wastes discharged from large poultry operations are a matter of increasing concern, as are wastes from numerous fish farms scattered throughout much of the region.

As with municipal and industrial inorganic wastes, further detailed study is needed, both to more explicitly define agricultural inorganic waste loads and to integrate them into a total water quality management program for the Lower Mississippi Region.

Bacteria

Large quantities of bacteria are associated with wastes from municipal, industrial, and agricultural sources. Fecal wastes from humans and from livestock and poultry contain extremely high concentrations of coliform bacteria which are not only harmless but constitute an intestinal flora that promotes digestion and health in the host. Coliform bacteria are also common soil bacteria, and surface runoff can cause intermittent high bacteriologic counts in the receiving water bodies. High concentrations of these harmless coliform bacteria are an indicator of the possible presence of disease bacteria that cause waterborne diseases such as typhoid fever, amoebic dysentery, gastroenteritis, and cholera. Although not prevalent in our time because of generally adequate sanitary precautions, these bacteria occur in the fecal wastes of diseased individuals and are, therefore, associated with the coliform bacteria. Persistent high coliform counts in samples of receiving water indicate a near source of bacteriological pollution of municipal or industrial origin.

Bacteria generally occur in sanitary wastes of all industries in the Lower Mississippi Region; however, the largest quantities occur in the waste water of some sugar refineries and factories, canning factories, slaughter houses, fish processing plants, and paper mills.

The bacteria problem, expressed in terms of average daily flow of sewage containing bacteria concentrations high enough to constitute a potential health problem, is displayed in table 12.

Table 12 - Flows Containing Harmful Bacteria, Lower Mississippi Region

Program	1970	1980	2000	2020
		(Million gallons per day)		
A		624.0	869.5	1,190.1
	514.2			
B		675.1	978.7	1,358.4

EXISTING TREATMENT

Treatment levels provided by municipalities and industries vary widely when comparing specific cities and towns and industrial plants. Average treatment levels were estimated and are shown by State in table 13.

Table 13 - Existing Waste Treatment Levels, Lower Mississippi Region

State	Bacterial Removal (Percent)	5-Day BOD Removal (Percent)	
		Municipal	Industrial
Arkansas	10	80	55
Kentucky	90	70	55
Louisiana	75	50	55
Mississippi	30	50	55
Missouri	5	80	55
Tennessee	100 1/	75 1/	55

1/ Exclusive of Memphis, which had no treatment in 1970.

Applying these treatment levels to gross waste production provides an organic waste removal equivalent to 1,933,800 #BOD_5 in 1970. Of a total of 514 m.g.d. of wastewater containing bacterial pollution in 1970, 273 m.g.d. received adequate chlorination. The existing treatment identified by municipal and industrial categories and wastewaters adequately treated to remove bacteria are shown by WRPA in table 14.

Table 14 - Pollutant Removal Provided by Existing Treatment
Lower Mississippi Region

WRPA	Discharge Receiving Adequate Chlorination 1/	Reduction of BOD_5 2/ Municipal	Industrial
2	3.5	43,220	20,310
3	27.3	33,990	192,490
4	12.1	23,240	51,240
5	19.0	46,030	456,380
6	4.6	8,340	91,580
7	1.9	4,340	97,920
8	25.2	23,310	196,800
9	44.6	40,440	222,900
10	134.7	92,090	289,180
Total	272.9	315,000	1,618,800

1/ Discharge in million gallons per day (m.g.d.).

2/ BOD_5 in pounds.

WATER QUALITY CONTROL NEEDS

Water quality control needs exist wherever pollutants are discharged to water supplies. As stated under "Purpose", quantified needs herein are limited to organic, or biodegradable wastes, and bacteria. Organic pollutants are expressed in pounds of BOD_5 per day. Bacterial pollutants are expressed in terms of flow in m.g.d. requiring treatment.

As explained in "Methodology", municipal and industrial waste loadings are considered point loadings to streams, whereas 95 percent of agricultural loadings are considered non-point sources of pollution. Projected net loadings to streams to the year 2020 are based on calculated total raw waste production minus the quantity of BOD or bacteria removed by present (1970) treatment held as a constant through the projected 50-year period. Table 15 displays future point source municipal and industrial BOD needs, table 16 displays point source agricultural BOD needs, and table 17 shows needs for control of harmful bacteria.

Table 15 - Municipal and Industrial Organic Pollution Control Needs, Lower Mississippi Region

Load Category	1970	Program	1980	2000 (#BOD_5)	2020
Municipal					
Total	658,450	A	777,440	1,074,300	1,444,540
Exstg Trmt	315,000		315,000	315,000	315,000
Net Need	343,450		462,440	759,300	1,129,540
		B	840,290	1,209,980	1,645,820
			315,000	315,000	315,000
			525,290	894,980	1,330,820
Industrial					
Total	2,943,250	A	3,848,680	6,896,090	13,451,430
Exstg Trmt	1,618,800		1,618,800	1,618,800	1,618,800
Net Need	1,324,450		2,229,880	5,277,290	11,832,630
		B	4,221,260	7,992,870	15,518,780
			1,618,800	1,618,800	1,618,800
			2,602,460	6,374,070	13,899,980
Total					
Total	3,601,720	A	4,626,120	7,970,390	14,895,970
Exstg Trmt	1,933,800		1,933,800	1,933,800	1,933,800
Net Need	1,667,920		2,692,320	6,036,590	12,962,170
		B	5,061,550	9,202,850	17,164,600
			1,933,800	1,933,800	1,933,800
			3,127,750	7,269,050	15,230,800

Table 16 - Agricultural Organic Point Source Loads, Lower Mississippi Region

	1970	Program	1980	2000 (#BOD_5)	2020
Waste Load 1/	221,180	A	264,690	346,270	450,670
		B	264,690	371,810	486,390

1/ Direct untreated point-source loads to streams.

Table 17 - Bacterial Pollution Control Needs, Lower Mississippi Region

	1970	Program	1980	2000	2020
			(Million gallons per day)		
Total Discharge	514.2	A	624.0	869.5	1,190.1
Chlorinated	264.8		264.8	264.8	264.8
Net Need	249.4		359.2	604.7	925.3
		B	675.1	978.7	1,358.4
			264.8	264.8	264.8
			410.3	713.9	1,093.6

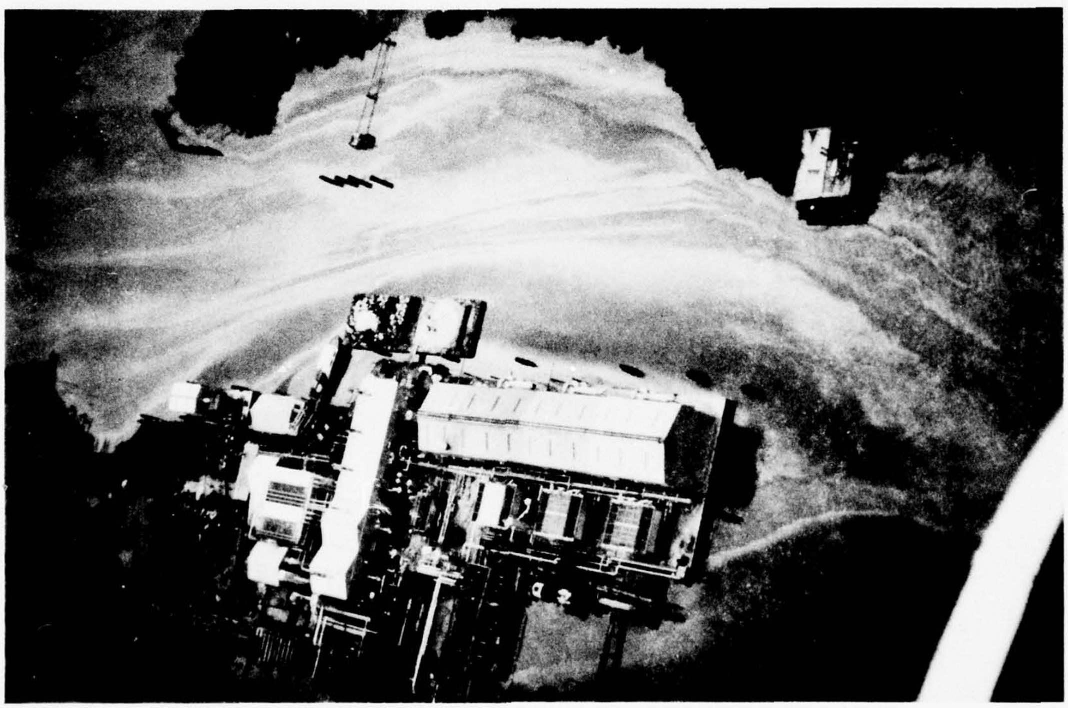
The unsatisfied or net need indicated in the 1970 column of the tables indicates that there are significant pollution control problems in existence in the Lower Mississippi Region at the present time. The more notable of these problem areas are displayed on figure 3.

Only 5 percent of the total BOD waste production generated by the agricultural sector in the Lower Mississippi Region enters the region's surface waters as point sources of pollution. The remaining organic wastes are disposed of using various methods including direct land application, recycling, aerated lagoon-irrigation systems, holding tanks, or some combination of the above. Nonetheless, these wastes can pose an ultimate surface water problem unless proper land management practices are instituted and maintained.

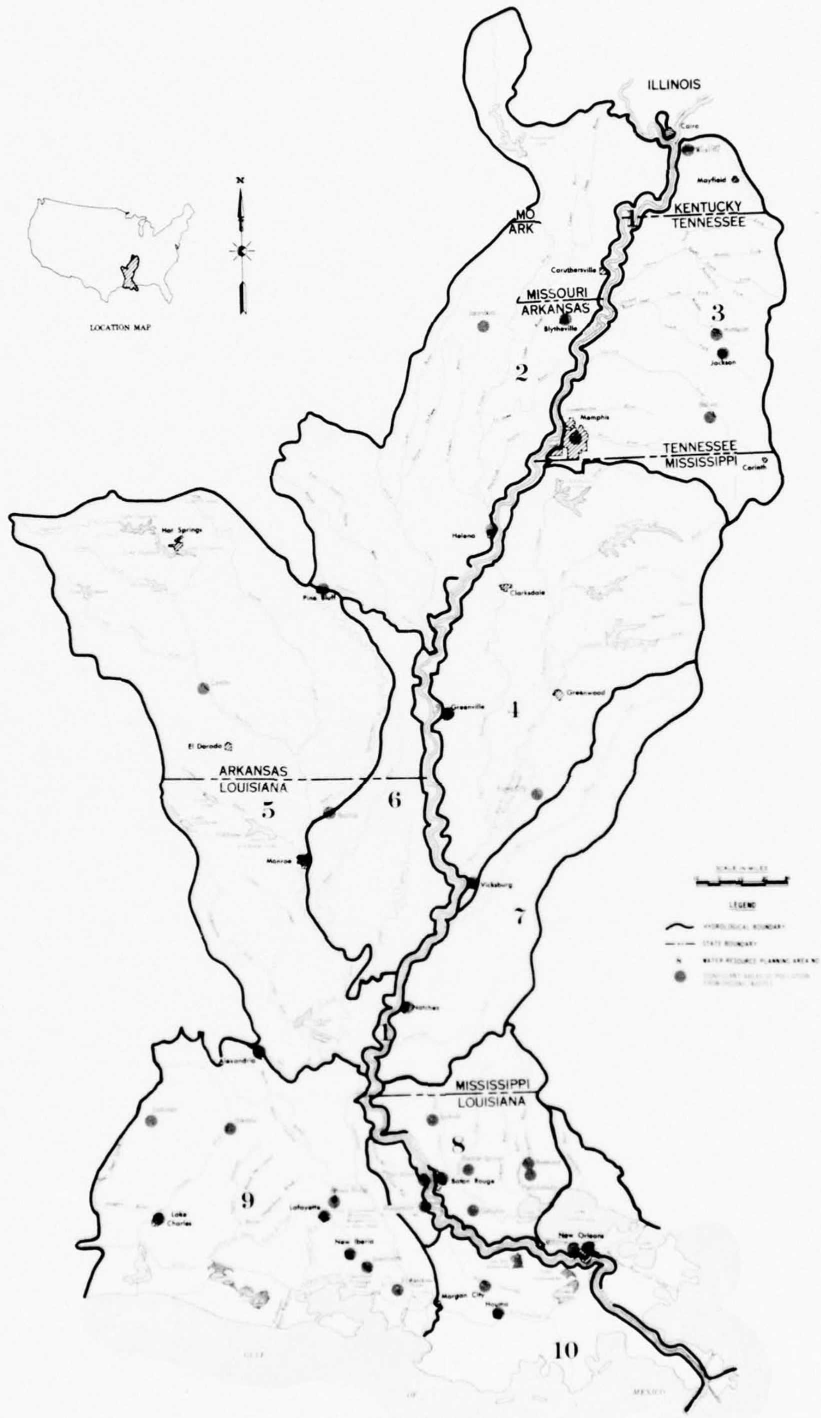
A need to control bacterial pollution exists at several locations within the region. In 1970 the net regional bacterial pollution control need (unchlorinated discharge) was 249 m.g.d. The most serious problems at present are in WRPA's 3 and 10, the Memphis and New Orleans areas. Under the National Income Program, the region's net need will increase to 925 m.g.d. by 2020, with 30 percent expected to occur in WRPA 3 and 23 percent in WRPA 10. The remaining WRPA's will share the rest of the

need in varying percentages. Under the Regional Development Program, the region's need for bacterial pollution control will be slightly higher with all WRPA's maintaining about their same relative percentages of the problem as for the National Income Program.

In the Lower Mississippi Region there is a need for additional data on municipal, industrial, and agricultural pollution sources and on present methods and effectiveness of waste-water treatment. Additional data is also needed on stream and lake water quality. This more detailed pollution source inventory and water quality surveillance system would establish a base-line record for all major streams and lakes. Moreover, it would provide more information for determining major patterns of pollution under present conditions and for making broad predictions of future water quality conditions under projected changes in population and economic activity.



Streaks on water are the result of an accidental oil spill. This is a problem in the Lower Mississippi Region - particularly in coastal areas.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

SIGNIFICANT AREAS OF POLLUTION FROM ORGANIC WASTES LOWER MISSISSIPPI REGION

FIGURE 3

W R P A 1

STUDY AREA DESCRIPTION

General

WRPA 1 comprises 2,435 square miles along the Mississippi River from its confluence with the Ohio River to its mouth. The planning area includes the land between the levees or to the top of the river banks where levees are nonexistent (see figure 4).

The Mississippi River, besides being a source of water supply to many communities and industries in adjacent WRPA's, receives large quantities of municipal and industrial wastewaters. WRPA 1 has very little, if any, water needs or sources of pollution of its own.

Water pollution problems in WRPA 1 include: (1) point source discharges of organic and non-organic wastes that locally exceed the waste assimilative capacity of the Mississippi River and regionally have very serious effects on its suitability as a source of water for public supply and for the preservation of fish, shellfish and wildlife, (2) general bacteriological pollution from non-disinfected effluents, and (3) indeterminate levels of pollution from agricultural organic wastes, fertilizers and pesticides.

Population and Economy

There are no communities within this defined area. As a consequence, the population of WRPA 1 is considered transient and is ascribed to the adjacent water resource planning areas. Likewise, statistics on industry and agriculture affecting the Mississippi River are included in the adjacent planning areas.

Selected Streams

The Mississippi River is the only stream in WRPA 1. Within the Lower Mississippi Region it extends from the confluence with the Ohio River near Cairo, Illinois, to Head of Passes, Louisiana, a distance of about 954 miles.

Surface runoff from rainfall and snowmelt and ground water seepage sustain the flow of the Mississippi. These processes, applying directly to the Mississippi and indirectly to the vast network of major and minor tributaries, all contribute to the flow of the river. The waste assimilative capacity is least during the months of September

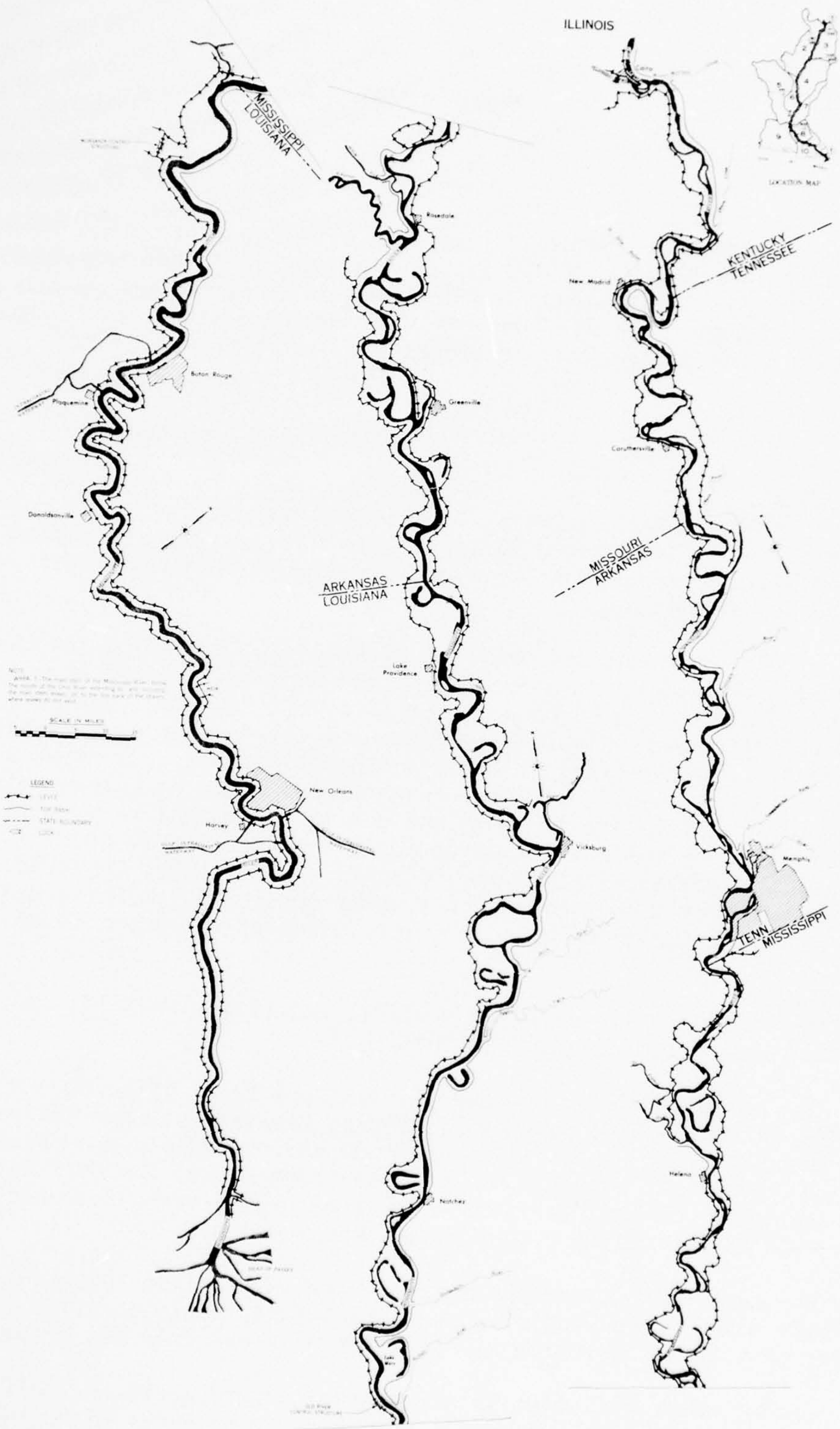
and October when the river is at lowest flow. However, even though the river is very large, the assimilative capacity has been utilized to a degree that must be reduced.

Appendix C, Regional Climatology, Hydrology and Geology, presents a streamflow summary for selected sites in WRPA 1. The recorded flows range from a maximum momentary flow of 2,159,000 c.f.s. at Arkansas City, Arkansas, to a daily minimum flow of 69,000 c.f.s. at Hickman, Kentucky.

The flow of the Mississippi River is unregulated in WRPA 1 except through the operation of the Atchafalaya Basin floodway and the Bonnet Carre floodway, constructed to protect the cities of Baton Rouge and New Orleans during potential flooding conditions by partial diversion of Mississippi River water. Further information on the flow characteristics of the Mississippi River is available from Appendix C.

Major Aquifers

Major aquifers underlying the narrow geographic boundaries of WARP 1 are not specifically considered in this appendix. For details regarding the geology and ground-water conditions, see Appendix C.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WATER RESOURCE PLANNING
AREA 1

FIGURE 4

PRESENT STATUS

Water Use

WRPA 1 has very little, if any, water needs of its own. As a consequence, the topic of water use is not considered for this planning area. Water withdrawals from the Mississippi River for use in the adjacent planning areas are considered in the 1970 water use figures and future needs projections presented for each WRPA.

Water Quality

Surface Water

In WRPA 1, water analyses for selected sampling stations on the Mississippi River are listed in table 18. Two analyses are included for each station to reflect water quality conditions under relatively high and low streamflow.

The analyses indicate that the Mississippi River is a calcium bicarbonate type water with recorded high concentrations of 61 mg/l calcium and 168 mg/l bicarbonate. Gross aspects of water quality, as determined by dissolved solids, sulfate and chloride concentrations, indicate that the Mississippi is of acceptable quality for drinking purposes. Recommended limiting concentrations for dissolved solids, sulfate and chloride are 500, 250 and 250 mg/l, respectively. High concentrations of these three water quality parameters in the Mississippi River are 344, 96 and 36 mg/l, respectively. However, drinking water criteria involve many water quality parameters, and the river is unacceptable for this and other purposes without pretreatment.

Ground Water

The water quality of major aquifers underlying WRPA 1 is not specifically considered in this appendix.

The channel bed of the Lower Mississippi River is below sea level from the Gulf of Mexico to near Vicksburg, Mississippi, and saline Gulf water moves varying distances upstream depending largely upon river flow. Because salt water is denser than fresh water, the Gulf water moves along the channel bottom beneath the fresh river water which flows with little mixing over the salt water wedge.

The maximum upstream movement of salt water since 1929 (14) was 120 river miles above Head of Passes, Louisiana. This location is near Luling, Louisiana, approximately 15 miles upstream from New Orleans.

Ground water pollution is a potential hazard where the salt water wedge occupies the river channel. Possible ground water withdrawals

Table 18 - Stream Quality, WRPA 1

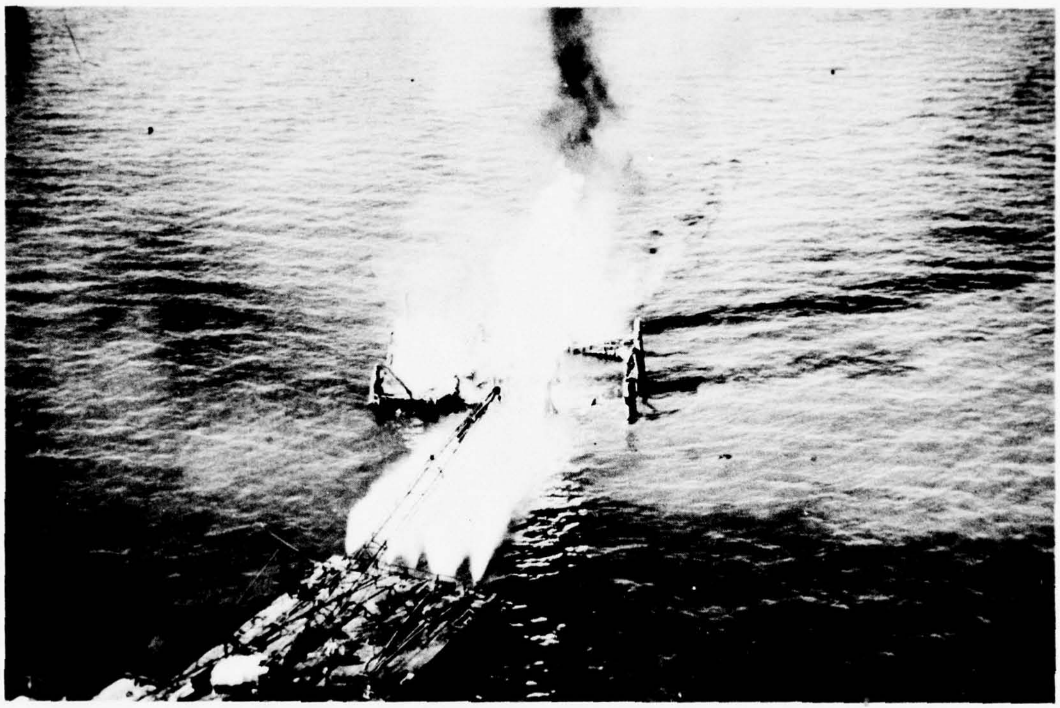
Stream Sampling Station 1/	Date of Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/l)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/l)	Temp. °C
Mississippi River at Hickman, Ky.	9-13-69 9-24-69	197,000 65,000						96 51	17 14		310 262	520 480	7.2 6.7	5.8 4.0	27 28
Mississippi River at West Memphis, Arkansas	10-10-66 7-3-66	211,000 629,000						87 38	34 10	0.4			7.7 7.6	8.4 5.3	19 24
Mississippi River near Vicksburg, Mississippi	10-18-61 11-17-61	311,000 535,000	43 41	13 9.4	146 132	15 14	2.9 3.4	47 38	17 16	0.9 2.7	242 216	396 335	6.9 7.4		
Mississippi River near St. Francisville, Louisiana	11-11/20-63 2-11/19-57	137,000	61 23	8.7 4.5	168 64	34 7.1	3.3 2.2	76 22	33 10	1.2 3.8	342 111	525 197	7.6 7.7		16 2/ 15 2/
Mississippi River at Luling Ferry, Louisiana	12-21/31-65 3-21/31-64		58 26	16 5.1	168 67	37 7.6	3.2 2.2	92 29	36 12	1.7 3.2	344 126	538 223	7.2 7.1		11 2/ 12 2/
Mississippi River at New Orleans, Louisiana	11-7-67 1-5-68		46 33	9.8 8.4	128 97	28 11	3.6 2.1	68 36	33 15	0.1 3.9	272 178	455 294	6.9 7.4		16 12

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

2/ Average daily temperature.

from shallow wells located relatively near the river could cause salt water intrusion into the aquifers being pumped.

Preservation of the estuarine area depends on fresh water discharges through the Mississippi and Atchafalaya Rivers. The diversion of fresh water from the Mississippi River system to distant basins may cause a landward shift in the position of saline coastal waters causing fundamental changes in the aquatic life in the coastal swamps and in the estuaries. A potential problem related to the landward shift would be the possible overriding of shallow fresh water aquifers causing loss in reserves of potable water.



Blowout of an offshore well - potential threat to the estuarine area.

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

Municipal and Industrial

In describing stream pollution in the Lower Mississippi River, emphasis has been placed on the quantitative expression of organic waste discharges from municipal and industrial sources. In preparing information on pollution of the Mississippi River main stem, discharges from municipal and industrial sources located along the river, but not in WRPA 1, were ascribed to their respective water resource planning areas. This approach poses no problems in describing organic pollution of other streams in the Lower Mississippi Region. However, because of the very large waste assimilative capacity of the Mississippi River and the assumed total intermixing at the points of discharge, the pollution effects of organic waste discharges are nullified, and no water quality control needs are presented for the Mississippi River in WRPA 1 or in adjacent planning areas.

In reality, the waste assimilative capacity is exceeded at a number of locations. It is estimated that the total municipal and industrial discharge of organic wastes to the Mississippi River was more than 628,000 pounds of BOD_5 per day in 1970. The major areas of discharge are the Baton Rouge-New Orleans metropolitan and industrial complex and the Memphis area, which together account for 81 percent of the total estimated load discharged directly to the Mississippi River. By the year 2020 the loads are expected to increase to over 4,750,000 and 5,590,000 pounds of BOD_5 per day according to Programs A and B, respectively.

In addition to the organic waste loads directly discharged to the Mississippi River, tributary rivers such as the St. Francis, White, Arkansas, Ouachita, Red, Obion, Hatchie, Loosahatchie, Wolf, Yazoo and Big Black may contribute organic loads during periods of low flow.

Chemical analyses of the Mississippi River, indicate that minimum concentrations of dissolved oxygen occasionally are less than 5.0 mg/l. For example, at St. Francisville, New Orleans and Belle Chasse, Louisiana, the minimum dissolved oxygen concentrations are recorded at 4.2, 2.6 and 4.9 mg/l, respectively. In Zone One of the Mississippi River (stream reach from Arkansas-Louisiana border to 10 miles above Head of Passes) the present Louisiana water quality criteria for dissolved oxygen is that the concentration shall not be less than 75 percent of saturation at existing water temperature. Water temperature may not exceed 36°C (96.8°F). At this temperature 75 percent of saturation is 5.25 mg/l dissolved oxygen, which is the minimum permissible concentration. However, the present criteria specify that under extreme conditions, the dissolved oxygen may range between 5 mg/l and

4 mg/l for short periods of time, provided that the water quality is favorable in all other respects.

Agricultural

Land use within WRPA 1 provides no significant sources of pollution from agricultural sources. The planning area comprises 2,435 sq. mi. of which 575 sq. mi. is water, which includes the Mississippi River and oxbow lakes. Forests occupy 1,373 sq. mi., and pasture and cropland are 549 and 341 sq. mi., respectively. Other land comprises 97 sq. mi. and includes farmsteads, farm roads, feed lots (of relatively small size), ditch banks, hedge rows, investment tracts, coastal dunes and marshes not used for grazing. Most of the cropland is used for soybeans and wheat, and the levees are used for grazing mostly beef cattle. This land use pattern is expected to remain about the same in the future.

Due to the location of the land area in WRPA 1 and its characteristics, no sediment and erosion data were determined.

Non-Organic Wastes

Non-BOD wastewater discharges have a very serious effect on the water quality of the Mississippi River and its usefulness for public water supply, and for the preservation of fish, shellfish and wildlife. Important parameters in this respect are thermal wastewaters, heavy metals, nutrients, odor and taste, chemical oxygen demand, organic chemicals, pH, and oil and grease.

According to recent unpublished and published reports (15) by the Environmental Protection Agency on industrial pollution of the Lower Mississippi River in Louisiana, complex and often highly concentrated liquid wastes from 60 industries are discharged between St. Francisville and Venice. This reach of the Mississippi River is used for raw water supply for 40 water utilities serving about 1,500,000 people.

Thermal wastewaters are being discharged at temperatures and in quantities that are cause for concern. Present criteria allow temperatures to be raised no more than 3°C (5.4°F) above ambient water temperature, nor to exceed a maximum of 36°C (96.8°F). A number of large water using industries discharge heated wastewaters having temperatures from 40° to 80°C (104° to 176°F). At the water quality monitoring station at Luling Ferry, the maximum temperature was recorded at 124°F (51.1°C).

Heavy metals, nutrients, toxics, and odor and color causing substances are prevalent in wastewater discharges from the industrialized and populated Baton Rouge-New Orleans area. Heavy metals, such as

arsenic, cadmium, chromium, copper, lead, mercury, and zinc are often discharged in large quantities. Arsenic, cadmium, chromium, copper, lead, mercury, and zinc were discharged from a number of industries in quantities of five or more pounds per day. For example, five industries discharged arsenic in quantities ranging from 9.8 to 43 pounds per day, and eight industrial plants discharged cadmium ranging from 5.6 to 71.3 pounds per day. Twenty-nine plants discharge more than five pounds of chromium per day, and of these nine plants five exceed 100 pounds per day with 200 pounds being the maximum. Eleven industries discharge more than 10 pounds of copper per day and one plant as much as 396 pounds. Among 22 plants that discharge five or more pounds of lead per day, 9 discharge 100 or more pounds per day and one plant as much as 3,700 pounds. Mercury is generally discharged in small quantities and of seven plants that discharge more than one pound per day, the maximum discharge is 4.35 pounds. Zinc is discharged to the Lower Mississippi River from 28 plants contributing 10 or more pounds per day. Eight plants contribute more than 100 pounds per day and one plant as much as 1,317 pounds.

Nutrients include nitrite, nitrate, and phosphorus. Expressed as Kjeldahl nitrogen and total phosphorus, daily industrial discharges of over 200 pounds per day are common for each. The maximum quantities of 36,500 pounds per day Kjeldahl nitrogen and 109,000 pounds per day of phosphorus have been measured.

Odor problems are persistent. The average threshold odor in the raw water at six water treatment plants increased from 7.3 south of St. Francisville to 12.0 at New Orleans. River water odor varies from "earthy" or "musty" upstream to "chemical" or "petrochemical" downstream. The discharges from all 60 industrial plants had discernable odors. The average flow at New Orleans is considered to be 450,000 cfs. Threshold odor number at the intake of downstream water utilities indicate that odorous discharges from upstream industries are present when river water is withdrawn for pretreatment.

Phenolics, important in causing persistent taste problems, are discharged from 17 industrial plants in quantities of 10 or more pounds per day. Sampling of ten industries indicated discharges of more than 100 pounds per day to as much as 2,970 pounds per day.

Fifteen plants each discharged 40,000 pounds or more per day of chemical oxygen demand and ten discharged 20,000 pounds or more per day of total organic carbon.

Forty-six organic chemicals in trace amounts were present in the raw or treated water supplies from three water plants: the U. S. Public Health Service Hospital at Carville, the Carrollton plant of the City of New Orleans, and the Jefferson Parish #2 Water Plant at Marrero. Thirteen of these organic chemicals were present in wastes

from seven industrial plants. An additional forty-four organic chemicals were present in wastes from 10 industrial plants. These chemicals were not found in the finished water of the three municipal water plants.

The pH of industrial waste discharges ranges from 0.07 to 12.5. Relatively few of the industries have discharges that are at or near 7.0, which is the normal for unpolluted water.

Oil and grease are discharged in quantities commonly exceeding 100 pounds per day from the industries studied. There are 16 industries that discharge more than 1,000 pounds per day.

A survey of fisherman and wholesale fish dealers revealed that fish caught in the reach of the Mississippi River below Baton Rouge were not saleable because off-flavors in the fish made them unacceptable to the public. Experimental fish placed downriver from major industrial complexes developed pronounced off-flavor after 72 hours of exposure to the river water.

Six organic chemicals found in trace quantities in the finished water supplies at either the U. S. Public Health Service Hospital at Carville or the New Orleans Carrollton Plant, or both, have been shown by others to induce histopathological change in animals in chronic toxicity studies. Three of the organic compounds have been shown by others to be carcinogenic.

Many of the industries studied have initiated waste abatement programs as required by the State of Louisiana and by the Refuse Act Program of the Environmental Protection Agency.

Bacteria

Bacterial concentrations in the Mississippi River are high at a number of locations. The coliform counts per 100 ml ranged from 62,000 in November 1969 to 10,000 in February 1970 at West Memphis, Arkansas. At this location the fecal coliform counts per 100 ml ranged from 12,000 to 2,000 for the same months. Surface water criteria for public water supplies (7) specifies that the permissible criteria for coliform organisms and fecal coliforms are 10,000/100 ml and 2,000/100 ml, respectively. Desirable criteria are less than 100/100 ml and less than 20/100 ml, respectively. Water quality criteria for protecting the sanitation of shellfish growing areas call for a coliform median MPN (Most Porbable Number) that does not exceed 70/100 ml, and not more than 10 percent of the samples ordinarily exceed an MPN of 230/100 ml measured under the most unfavorable hydrographic and pollution conditions. Near St. Francisville, Louisiana, coliform counts ranged from 16,000/100 ml in June 1970 to 230/100 ml in May of the

same year. At the same location fecal coliforms ranged from 600/100 ml in June 1970 to 140/100 ml in April, 1970. Bacterial discharges from the New Orleans area have averaged 2,600/100 ml and reached a maximum of 90,000/100 ml, preventing the transfer of Mississippi River water to oyster growing areas in the east delta marshes. Lake Pontchartrain, which receives improperly treated sewage and storm waters, has periodic bacterial pollution problems on the south shore. This area provides water contact sports for the New Orleans metropolitan area.

WATER QUALITY CONTROL NEEDS

Two factors used in determining the water quality control needs in the Lower Mississippi Region are the waste assimilative capacities of the receiving streams and the degree of intermixing of waste discharges with the river water. The Mississippi River has a very large waste assimilative capacity; for example, at Memphis it is estimated at about 2,401,000 pounds of BOD_5 per day. At New Orleans the capacity is 1,892,000 pounds of BOD_5 per day. Intermixing is assumed to be total; that is, complete mixing throughout the entire cross-sectional area of the river at the point of discharge. The very large waste assimilative capacity and the assumed total mixing at the point of discharge combine to nullify the impact of all organic waste discharges, including those from the three largest population and industrial centers in the Lower Mississippi Region: Memphis, Baton Rouge and New Orleans.

In reality, the waste assimilative capacity of the Mississippi River is exceeded at a number of locations. The reason for this lies in the physical fact that waste discharges into the Mississippi River tend to follow the river's edge for considerable distances forming in effect, a stream within a stream. Given sufficient distance of travel, measured probably in many tens of miles, intermixing may be adequate to prevent dissolved oxygen reduction to below 5 mg/1. However, until such intermixing has occurred, low oxygen levels may be expected to develop within these substreams of waste water, and until more detailed information on the water quality of the Mississippi River is available, the areas where these problems occur cannot be defined.

W R P A 2

STUDY AREA DESCRIPTION

General

In 1970 the St. Francis-Lower White River Basin planning area (WRPA 2) was sixth in population in the Lower Mississippi Region. According to 1960 economic statistics, WRPA 2 was fourth in manufacturing and second in agricultural employment. It was the region's fifth largest producer of organic wastes from domestic and commercial sources in 1970, comprising 65 sewered communities of 1,000 or more inhabitants with a total population of 283,400 people. The WRPA ranked ninth and last in total organic wastewater production from industrial sources with 98 industries classified as producing biodegradable wastes in 1970. These industries generated organic wastes equivalent to those produced in an urban center of approximately 0.2 million people. WRPA 2 was fifth in total organic waste production from livestock and poultry. In 1970 this source produced organic wastes equivalent to an urban center of about 3.2 million people.

Water pollution problems in WRPA 2 include, (1) point source discharges of organic wastes that exceed the assimilative capacity of the receiving streams, (2) indeterminate levels of pollution from agricultural organic wastes, fertilizers and pesticides, and (3) general bacteriological pollution from non-disinfected effluents, and (4) a few instances of ground-water pollution.

Population

WRPA 2 comprises 16,723 square miles in southeastern Missouri and northeastern Arkansas (see figure 5). In 1970 a total of 626,700 people inhabited the planning area and by 2020 the population is expected to increase to 795,000 and 925,000 according to respective projections of Programs A and B.

Of the total 1970 population of 626,700, the urban population was 250,700, or 40 percent of the total. Table 19 lists the total and urban populations of WRPA 2 for 1970 and the corresponding projected population for 1980, 2000, and 2020 for Programs A and B.

There are 18 communities of 5,000 or more inhabitants. These are listed alphabetically by state in table 20 (see figure 5). Jonesboro, Arkansas, with 27,050 inhabitants, is the largest community. In addition, there are 51 communities whose combined population of 103,600 ranges from 1,000 to 5,000 per community.

Table 19 - Population, WRPA 2

Base Population 1970	Programs	Projected Population 1980	2000	2020
Total Population				
	A	625,000	684,000	795,000
626,700	B	671,000	766,000	925,000
Urban Population				
	A	288,000	383,000	509,000
250,700	B	309,000	429,000	592,000

Table 20 - Principal Communities, WRPA 2

Community 1/	County	State	Community Population 1970
Blytheville	Mississippi	Arkansas	24,752
Brinkley	Monroe	"	5,275
Forrest City	St. Francis	"	12,521
Helena	Phillips	"	10,415
Jonesboro	Craighead	"	27,050
Marianna	Lee	"	6,196
Osceola	Mississippi	"	7,204
Paragould	Greene	"	10,639
Stuttgart	Arkansas	"	10,473
Trumann	Poinsett	"	5,938
West Helena	Phillips	"	11,007
Wynne	Cross	"	6,696
Caruthersville	Pemiscot	Missouri	7,350
Charleston	Mississippi	"	5,131
Dexter	Stoddard	"	6,024
Kennett	Dunklin	"	9,852
Malden	Dunklin	"	5,374
Sikeston	Scott	"	14,390
Eighteen communities with a total population of			186,287

1/ Incorporated places (cities, villages, towns, or boroughs) of 5,000 or more inhabitants.

LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WATER RESOURCE PLANNING
AREA 2

FIGURE 5

Economy

Total employment in WRPA 2 in 1968 was 214,400. This is an increase of 6.3 percent over 1960. By 2020 the total employment, according to Program A and B projections, is expected to increase to 314,000 and 371,000 respectively. As compared to the other planning areas in the Lower Mississippi Region, WRPA 2 was sixth in total employment in 1968.

Ninety-eight industries that yield wastewaters in relatively large quantities and high BOD concentrations are located in WRPA 2. Food, paper, chemicals and petroleum products industries comprise about 98 percent of the organic waste producing industries in the planning area. Among these four major industrial groups, food and kindred products and chemicals and allied products comprise about 69 and 21 percent, respectively, of the total number.

Table 21 indicates the growth of employment and of industrial water use for Programs A and B to the year 2020. The indexes are an average of the employment and earnings.

Mining operations include metallic minerals and nonmetallic minerals. Iron and lead are probably the principal metals in terms of tonnages mined. Production figures for iron are withheld (confidential information), but for 1980 the projected production of iron and lead are estimated at 1,356,000 and 199,000 long tons, respectively. Among the nonmetallic minerals sand and gravel ranks highest in production at 3,401,000 short tons mined in 1969.

Agricultural production reports of livestock and poultry place cattle and calves and hogs and pigs among the most numerous of large farm animals. In 1970 there were 421,400 cattle and calves and 191,400 hogs and pigs, ranking WRPA 2 fifth in the Lower Mississippi Region with respect to production of cattle and calves and second in production of hogs and pigs. Table 22 indicates the projected increase in production to the year 2020 for Programs A and B.

Selected Streams

Left Hand Chute Little River, Bayou DeView, L'Anguille River and Bayou Meto receive the largest organic waste loads discharged in WRPA 2. The flow of these streams is sustained largely by ground-water seepage, by surface runoff from rainfall and to a minor extent by snowmelt. Their waste assimilative capacities are least during periods of lowest streamflow, which generally occur in the months of July through October, with October frequently being the most critical month.

Table 21 - Employment, WRPA 2

Program	Year	Major Industry Employment	Major Industry Earnings 1/	Indexes 2/ Employment	Indexes 2/ Earnings	Indexes 2/ Water Use
A	1968	214,400	1,074	100	100	100
	1980	214,000	1,523	99.5	142	121
	2000	252,000	3,241	118	302	210
	2020	314,000	7,215	146	672	409
B	1968	214,400	1,074	100	100	100
	1980	235,000	1,670	109	155	132
	2000	292,000	3,748	136	349	243
	2020	371,000	8,510	173	792	483

1/ In millions of dollars.

2/ Industrial water use indexes are an average of employment and earnings indexes.

Table 22 - Numbers of Livestock and Poultry, WRPA 2

Livestock and Poultry	Numbers of Livestock and Poultry 1970	Program	1980	2000	2020
Cattle and Calves	421,400	A	536,700	722,400	970,200
		B	536,700	766,000	1,041,800
Milk Cows	17,800	A	16,300	20,200	24,600
		B	16,300	21,700	26,500
Hogs and Pigs	191,400	A	218,400	285,300	370,300
		B	218,400	306,400	397,700
Sheep and Lambs	6,100	A	4,700	5,500	6,800
		B	4,700	5,900	7,300
Chickens	2,406,600	A	2,643,900	3,384,400	4,287,100
		B	2,643,900	3,635,700	4,602,800
Broilers	3,315,800	A	4,624,500	6,457,200	8,669,200
		B	4,624,500	6,936,600	9,309,600
Turkeys	17,700	A	23,600	33,200	44,800
		B	23,600	35,700	48,200

Appendix C contains a streamflow summary for selected sites in WRPA 2. Streamflow characteristics are affected by flow regulation and withdrawals for water supply. The recorded flows range from a maximum momentary flow of 536,000 cfs on the Arkansas River at Little Rock, Arkansas, to a minimum momentary flow of 0 cfs on the St. Francis River, White River, Cache River and Bayou DeView. Zero flow is assumed to occur on numerous small streams thoughout the planning area. Minimum annual flows range from 13,100 cfs near Clarendon, Arkansas, to 141 cfs on Bayou DeView near Morton, Arkansas.

Streamflow characteristics are affected by flow regulation for flood control, navigation, electric power generation, and domestic and industrial water supply and by surface water withdrawals for purposes of fish and wildlife conservation, electric power generation and irrigation. The Arkansas River, for example, is regulated for navigation and five multipurpose reservoirs are presently in operation between Little Rock, Arkansas, and Tulsa, Oklahoma. Further information on streamflow characteristics and on reservoirs with total capacities of 5,000 acre-feet or more is presented in Appendix C.

Major Aquifers

Ground water supplies in WRPA 2 are obtained from aquifers that comprise rock units of Quaternary, Tertiary, Cretaceous, Pennsylvanian, Ordovician, Cambrian and Precambrian age. Aquifers that yield major quantities of water for municipal, industrial, and agricultural use are the Quaternary alluvium, the Claiborne and Wilcox Groups of Tertiary age, and the McNairy and Nacatoch Sands of Cretaceous age.

The water quality of these aquifers is discussed in the next section of this appendix. A listing of aquifers in WRPA 2 is presented as part of table 24 of that section. For details regarding the geology of the aquifers, see Appendix C.

PRESENT STATUS

Water Use

Water use for municipal supply, industry, and irrigation totaled 2559.6 mgd in 1970. Municipal supply accounted for 34.8 mgd (1.3 percent), industrial use for 38.8 mgd (1.5 percent) and irrigation for 2,486.0 mgd (97.1 percent) of this total. As compared to the other planning areas, WRPA 2 was third in total water use. By 2020 it is expected that water use for Programs A and B will increase by 137 and 176 percent for municipal supply, by 756 and 908 percent for industry and 16 and 34 percent for irrigation.

Cooling water used for thermal electric power generation totaled 399.0 mgd in 1970, and thus constituted the third largest water demand in WRPA 2. As compared to the other planning areas, WRPA 2 ranked fifth in total thermal electric cooling water requirements. By 2020 it is expected that this water use will increase 92 percent for Programs A and 123 percent for Program B.

Water Quality

Surface Water

In WRPA 2 water analyses are available on the St. Francis River, Little River, White River, Bayou Meto and the Arkansas River. These streams have calcium bicarbonate type waters with maximum recorded concentrations of 76 mg/l calcium and 304 mg/l bicarbonate. The maximum dissolved solids, sulfate, and chloride concentrations are 476, 67 and 159 mg/l, respectively, indicating that in terms of these three parameters and in relation to their recommended limiting concentrations for drinking water, the streams are of acceptable quality. Selected analyses of water sampled under relatively high and low streamflow are listed for these major streams in table 23.

The Arkansas River project, started in 1957 and scheduled for completion in 1973 has involved the construction of 17 locks and dams on the Arkansas River proper and of eight reservoirs. The storage capacity and operation of this vast waterway and reservoir system have decreased the extremes in water quality that were experienced during the seasonal high and low flows that occurred prior to project construction. At Little Rock, for example, the net effect of upstream retention, intermixing, and controlled releases of seasonal waters have reduced maximum concentrations from 1,240 to 159 mg/l for chloride, 2,400 to 476 mg/l for dissolved solids and 4,150 to 714 micromhos for specific conductance.

Table 23 - Stream Quality, WRPA 2

Stream Sampling Station	Date of Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/l)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/l)	Temp. °C
St. Francis River near Fredricktown, Missouri	2-4-63 3-11-63				115 63	6.3 3.3		24 18	5.4 2.4	1.8 1.7	155 86	249 139	8.3 7.6		
St. Francis River at St. Francis, Arkansas	11-13-69 5-12-70	218 5,880	31 10	14 5.5	152 48	4.5 2.3	1.6 2.0	7.4 9.0	3.2 2.6	.6 3.6	146 74	279 102	7.9 7.7	9.7 6.0	10 24
St. Francis River at Lake City, Arkansas	8-28-58 4-30-58	977 6,210	32 17	11 6.5	146 76	4.1 3.9		9.0 10	2.5 3.0	1.6 0.9	132 78	234 148	8.2 6.2		
Right Hand Chute of Little River at Riverdale, Arkansas	5-11/20-59 1-26/31-59	1,029 5,167	64 15	14 4.6	254 58	13 3.6	2.5 3.9	19 12	12 4.5	3.9 4.4	288 81	432 127	7.9 6.9		22-26 4 2/
Left Hand Chute of Little River at Lepanto, Arkansas	10-27-65	301	76	17	304	10	1.8	27	4.9	0.1	311	485	8.1	8.4	
St. Francis River Floodway near Marked Tree, Arkansas	4-29-58 8-20-58	8,720 2,520	34 24	10 8.3	156 110	13 3.7		12 7.0	7.0 2.5	0.6 1.4	156 101	252 191	8.3 7.4		
St. Francis River at Marked Tree, Arkansas	12-18-69 6-19-70	219 2,660	67 18	14 4.7	262 76	9.2 3.1	2.3 2.9	27 8.0	5.0 3.1	1.6 2.4	275 92	449 146	8.0 7.4	10.8 5.4	7 27
St. Francis River at Parkin, Arkansas	8-27-58 5-7-58	1,880 9,390	58 12	17 3.6	230 50	7.4 4.8		12 11	8.0 1.0	1.6 2.0	227 59	390 103	8.5 7.2		
St. Francis River near Riverfront, Arkansas	8-27-58 5-7-58	1,790 15,600	33 18	11 9.4	144 86	4.6 2.3		11 11	2.5 4.0	1.2 1.2	136 88	239 159	8.3 8.0		
White River at De Valls Bluff, Arkansas	10-30-69 5-01-70	8,020 66,900	37 20	15 5.8	166 84	2.5 1.3	1.3 1.7	4.8 6.8	3.2 2.3	11 .4	159 94	292 147	8.5 7.3	11.0 6.1	14 21
Arkansas River at Little Rock, Arkansas 2/	11-28/29-53 3-3-57	8,600 29,200	154	42	121 40	617		48 36	1,240 27	2.4 2.6	2,400 105	4,150 179	7.5 7.8		9 1/ 10
Arkansas River at Lock and Dam No. 6 below Little Rock, Arkansas	9-09-70 4-20-70	10,100 135,000	42 48	10 11	130 122	80 108	4.2 3.3	47 67	124 159	1.0 2.0	403 476	714 341	8.1 7.4	8.2 11.0	29 9
Arkansas River at Dam No. 2	9-15-70 3-24-70		42 16	9.5 3				36 16	123 38	0 .9		526 233	7.8 7.6	8.3 10.9	29 10
Bayou Meto near Stuttgart, Arkansas	6-24-70 3-24-70	25 1,250	15 5.6	5 0				24 9	14 5	2.4 .9		151 62	7.2 6.7	3.4 8.2	28 14

1/ Before construction of the Arkansas River navigation system.

2/ Average daily temperature. Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

Ground Water

In WRPA 2 analyses of ground water are available from aquifers of Quaternary, Tertiary, Cretaceous, Pennsylvanian, Ordovician, Cambrian and Precambrian ages. The analyses listed in table 24 represent ranges in chemical composition of well water from each aquifer as based on maximum and minimum concentrations of dissolved solids, sulfate and chloride.

Most aquifers that yield water meeting the recommended limiting concentrations for drinking purposes are of the calcium bicarbonate type. Exceptions to this are parts of the Claiborne Group, the Atoka Formation and the Potosi Dolomite which yield bicarbonate waters with approximately equal concentrations of calcium, magnesium and sodium. The Nacatoch Sand, represented by one water analysis, yields a sodium bicarbonate water.

As indicated in table 24, several aquifers or portions of aquifers yield water exceeding the recommended limiting concentrations for drinking water. The maximum concentrations of these waters range in dissolved solids from 617 mg/l (Cockfield Formation) to 1,990 mg/l (Potosi Dolomite), in sulfate (only one sample) a concentration of 1,100 mg/l (Potosi Dolomite) and in chloride from 270 mg/l (Recent Alluvium) to 618 mg/l (Cane River Formation). Sodium chloride water is the most common type from these aquifers containing excessively mineralized waters.

Appendix C shows the base of fresh water in the Coastal Plain aquifers of the Lower Mississippi region. For the purpose of this report, fresh water is defined as having a dissolved solids concentration of 1,000 mg/l or less. The naturally polluted ground waters contain more than 1,000 mg/l and occur in WRPA 2 at depths of 0 feet below mean sea level in Butler, Stoddard, and Scott Counties, Missouri, to depths of more than 2,000 feet below mean sea level in Pemiscot County, Missouri, and Mississippi, Craighead and Poinsett Counties, Arkansas.

The recent U. S. Geological Survey study of ground water pollution (4) lists no major occurrences in WRPA 2. However, there are extensive areas in the Lower Mississippi Region where hydrologic conditions are favorable to ground water pollution. Mississippi County, Arkansas, is included in such areas (3). A large county centrally located in WRPA 2, it is directly underlain by an extensive aquifer of Quaternary alluvium deposited by the ancestral Mississippi and Ohio Rivers. The nonpumping water levels are generally less than 10 feet below land surface over most of the county throughout much of the year. In the Spring water levels are often less than five feet below land surface. Numerous shallow domestic pitcher pump wells of 1 1/4 inch diameter are in use throughout the county. Where these wells are located near or in close proximity to outhouses, pig pens or the like, local pollution of shallow ground water by seepage from the surface is a potential threat. Of the

Table 24 - Ground-Water Quality, WRPA 2

Aquifer System	Well No.	Well Depth (ft.)	Date of Collection	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH	Temperature (°C)
Quaternary															
Recent Alluvium	1	91	3-17-54	39	9.9	210	210	0.0	27	270		762		7.4	
	2	80	6-7-55	23	4.2	84	8.6	0.0	9.9	0.5	0.0	113		7.8	17
Alluvium (Pleistocene)	3	179	8- -54	63	17	265	267		4.1	400	0.4	930	1690	7.4	18
	4	48	9-7-55	6.2	0.8	24	5.1		3.0	6.0		48	657	6.0	17
Tertiary															
Clairborne Group	5	378	8-4-61	65	26	344	15	1.6	12	5.5	0.9	319	515	7.6	18
	6	135	8-8-67	2.6	1.0	19	4.1	0.5	0.2	3.2	3.2	44	46	6.3	20
Cockfield Formation	7	250	3-9-56	125	31	484	58	5.2	44	82	1.4	617	1030	7.4	17
Sparta Sand	8	420	3-16-61	43	13	432	367	7.1	0.0	440	1.1	1220	2040	7.3	19
	9	438	5-31-61	66	15	314	28	4.5	5.6	18	1.4	314	516	7.3	20
Cane River Formation	10	1508	6-27-46	3.8	1.3	610	616	16	1.1	618	0.8	1570	3520	7.8	27
Wilcox Group	11	465	2-3-70	66	23	323	12	2.6	11	7.3	0.0	404		7.8	
	12	125	3-26-59	4.4	1.0	18	3.0	0.3	0.8	5.0	0.6	43	48	6.1	15
Cretaceous															
McNairy Sand	13	1650	8-13-69	74	22	15	242	15	58	452	0.0	1120		7.7	31
	14	286	2-26-52	27	9.9	135	14	0.0	15	8.8		165		6.2	
Nacatoch Sand	15	976	6-19-56	7.9	1.3	352	168	4.9	9.4	74	1.4	457	768	8.0	23
Pennsylvanian															
Atoka Formation	16	11	6-21-55	39	8.7	210	126		5.0	6.0	0.8	214	351	8.2	16
	17	160	9-26-60	7.9	4.3	44	9.4	0.8	5.6	9.5	3.0	71	154	6.3	20
Ordovician															
Plattin Formation	18	460	6-13-63	98	13	338	11	0.0	6.6	13	0.8	389		7.1	
St. Peter Ss	19	433	9-7-66	93	34	331	115	5	11	246	0.4	749		7.1	
	20	921	10-26-40	74	21	337	11	0.0	6.6	13	0.8	343			
St. Peter-Everton	21	1035	5-16-68	82	28	340	27	0.0	16	66	0.7	450		7.1	
Everton Formation	22	144	8-21-64	69	33	360	19	1.2	24	29	1.6	387		6.8	
Smithville-Powell	23	700	11-20-68	74	36	412	11	0.5	6.4	15	10	495		7.4	
Jefferson City Dolomite	24	740	10-28-32	14	39	241	22	0.0	19	6.3	22	291			
Roubidoux Formation	25	901	1-30-69	58	25	272	5.7	0.3	19	8.5	0.0	298		7.1	
	26	536		62	22	314	21		6.6	18		294		7.5	
Gasconade Dolomite	27	508	6-3-43	66	35	345	11	0.0	13	19	6.0	469			
	28	500	12-29-70	66	33	397	10	0.7	7.0	5.0	0.9	393		7.7	
Lower Gasconade	29	400	1-14-70	46	26	250	11.5	0.4	10	2.4	0.0	303		7.3	
	30	650	1-2-70	29	19	165	0.9	1.9	3.9	4.1	1.3	197		7.3	
Gunter Member	31	2075	2-28-56	103	51	427	45	0.0	9.9	130	0.4	751		7.3	
	32	1200	3-30-49	17	7.0	86	12	0.0	8.0	10		104		7.7	
Cambrian-Upper Series	33	221	9-21-67	38	22	221	2.4	0.0	3.0	2.7	0.0	183		7.5	
	34	221	1-27-66	36	23	171	4.7	0.0	6.9	5.0	8.1	186		8.05	
Potosi Dolomite	35	1490	5-23-49	464	3.2	11	14	0.0	1100	66	0.0	1990		8.4	
	36	2910	10-28-32	78	27	298	99	0.0	8.2	163	9.0	639			
Derby-Doerun Dolomite	37	3009	2-20-45	57	12	84	329	0.0	133	467		1240			26
Bonneterre Formation	38	250	1-26-53	32	38	299	9.1	0.0	21	14	5.3	484		7.4	
	39	225	1-13-55	18.8	31.5	242	19.5	0.0	59.9	14.7	5.8	331		7.0	
Lamote Ss.	40	503	6- -39	48	33	294	8.3	0.0	11	5.1	1.5	306			
	41	1150	10-31-63	35	23	208	9.9	1.4	18	8.1	0.1	233		7.6	
Precambrian	42	95	12-11-64	34	18	174	6.0	0.0	6.9	6.3	0.0	177		7.95	
	43	36	8-6-65	16	4.8	41	7.7	0.0	5.8	4.2	0.1	66		6.3	

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

58 shallow wells listed in that study, 76 percent were less than 35 feet deep, 40 percent were less than 25 feet, and 21 percent were less than 20 feet deep. Minimum well depth was 13 feet.

Relatively high nitrate concentrations can be strongly suggestive of ground water pollution from local surface sources. Concentrations of more than 45 mg/l should be considered unsafe for infant feeding (5). Water samples were taken from 28 of the shallow wells and these had depths from 13 to 60 feet, and averaged 29 feet. The nitrate concentration ranged from 0 to 80 mg/l and averaged 6.9 mg/l. By comparison, pollution of the deeper portions of the same aquifer is unlikely, and the nitrate concentrations may represent a natural background for the aquifer. Eighteen wells penetrating the Quaternary alluvium from 100 to 150 feet deep yielded water with nitrate concentrations ranging from 0 to 9.1 mg/l, and with an average nitrate concentration of 1.6.

Relatively high chloride concentrations can also be strongly suggestive of ground water pollution from local surface sources. In the 28 shallow domestic wells the chloride concentrations ranged from 2 to 66 mg/l and averaged 18.1 mg/l. In the 18 wells penetrating the deeper portions of the same aquifer, the chloride concentrations ranged from 1.2 to 34 mg/l and averaged 6.8 mg/l.

The Sparta Sand near the city of Brinkley, in Monroe County, Arkansas, yields brackish water locally. The chloride and dissolved solids concentrations are 440 and 1,220 mg/l, respectively.

Figure 2 shows the location of the reported areas of ground-water pollution.

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

Municipal

WRPA 2 has 65 sewered communities of 1,000 or more inhabitants. The total population served in 1970 is estimated at 283,400, as shown in table 25. The total daily raw waste production is 54,020 pounds of BOD. According to Programs A and B, the sewered population is expected to be 534,800 and 621,900 by 2020, which are increases of 89 and 119 percent, respectively. Correspondingly, the total raw BOD waste production will increase to 113,380 pounds per day by 2020 for Program A and to 131,860 for Program B.

Of the 65 sewered communities with 1,000 or more inhabitants, there are 47 (70 percent of the WRPA total) that have less than 5,000 inhabitants. The total sewered population of these smaller communities is 101,500 or 33 percent of the total for WRPA 2. The average raw waste production per community is 389 pounds of BOD_5 per day. Ten communities (15 percent) are in the range of 5,000 to 9,900 inhabitants and have a total sewered population of 65,100 or 23 percent of the WRPA total. The average raw waste production per community is 1,227 pounds of BOD_5 per day. Eight communities (12 percent) are in the range of 10,000 to 49,900 inhabitants and comprise a sewered population of 121,300 or 40 percent of the total for WRPA 2. The average raw waste production per community is 2,729 pounds of BOD_5 per day.

Many of the sewered communities discharge their effluent to small streams that seasonally have little or no flow. As a consequence, even secondary treatment of sewage may be inadequate and local water quality problems may arise.

Industrial

In 1970 there were 98 industries classified as producing biodegradable wastes in WRPA 2. Major categories involved in this waste production were Food and Kindred Products (70 percent of the total number of industries in WRPA 2, Chemical and Allied Products (20 percent), Paper and Allied Products (6 percent), Petroleum and Coal Products (2 percent), Rubber and Plastics Products (1 percent), and Lumber and Wood Products (1 percent).

Industrial waste production is comparatively small in WRPA 2. The 98 industries inventoried are located in or near 28 communities, with Blytheville and Jonesboro, Arkansas, being the largest centers. In 1970 the combined municipal (domestic and commercial) and industrial loads discharged to the Left Hand Chute Little River from Blytheville and to Bayou DeView from Jonesboro were 2,890 and 1,569 pounds of BOD_5 per day,

respectively. Food canning companies produce the largest quantities of organic wastes in both cities.

As shown in table 25, the population equivalent for 1970 will increase from 205,100 to 755,000 and 845,400 by 2020 according to Program A and B. These are increases of 268 and 312 percent, respectively. The corresponding raw BOD waste load before treatment of 36,920 pounds per day in 1970 are projected to be 151,000 pounds per day by 2020 for Program A and to 169,090 for Program B.

Agricultural

WRPA 2 ranks fifth in the Lower Mississippi Region in total organic waste production from livestock and poultry. Among the seven categories of farm animals listed in table 22, cattle and calves is the largest in terms of waste production, accounting for 73 percent of the daily total. Sheep and lambs is the smallest category and totals 0.1 percent of the total waste production.

The total daily raw organic wastes produced by livestock and poultry in WRPA 2 in 1970, and estimated for the projected years, is indicated in table 26. As explained in the Regional Summary, agricultural animal wastes generally constitute non-point sources of pollution and the total waste production must, therefore, not be equated with BOD loads from municipal and industrial sources.

The total daily production of organic wastes from livestock and poultry in 1970 was 576,670 pounds of BOD_5. For Programs A and B this total is expected to increase to 1,262,990 and 1,356,280 pounds by the year 2020.

The land area in WRPA 2 affected by erosion in 1970 totalled about 20 percent and ranged from 3 percent along the Mississippi River to 23 percent in the White River Basin. The average gross erosion of the affected areas was 9.8 tons per acre/year and ranged from 1.5 in the Arkansas River Basin to 25.2 tons per acre/year in the L'Anguille River Basin.

The use of fertilizers on extensive tracts of cultivated land is a significant potential source of nutrients that can be carried to the streams by runoff and wind. Little information is available on this loss of fertilizers; however, it would appear that 10 percent may be a realistic low estimate. In 1969 the use of fertilizers in WRPA 2 totalled 843,295 tons, which were applied to 6,649,805 acres. This averages 254 pounds of fertilizer per acre per year.

There are no compiled figures on the quantities of agricultural pesticides used in the Lower Mississippi Region. However, insecticides and herbicides are applied by aerial and land spraying or dusting. The loss of significant quantities of pesticides carried to streams by

Table 25 - Municipal and Industrial Organic Waste Production, WRPA 2

Load Category	1970	Program	1980	2000	2020
			Daily Raw Organic Waste Production		
Municipal					
P.E. 1/	283,400	A	307,000	388,300	534,800
		B	329,400	434,900	621,900
# BOD 2/	54,020	A	61,860	82,400	113,380
		B	66,370	92,300	131,860
Industrial					
P.E.	205,100	A	235,100	387,700	755,000
		B	258,400	446,700	845,400
# BOD	36,920	A	44,670	77,530	151,000
		B	49,100	89,340	169,090
TOTAL					
P.E.	488,500	A	542,100	776,000	1,289,800
		B	587,800	881,600	1,467,300
# BOD	90,940	A	106,530	159,930	264,380
		B	115,470	181,640	300,950

1/ P.E. - Population equivalents: See Methodology.
2/ #BOD - Pounds of 5-day biochemical oxygen demand.

Table 26 - Organic Wastes from Livestock and Poultry, WRPA 2

	1970	Program	1980	2000	2020
BOD_5 1/	576,670	A	711,360	950,020	1,262,990
		B	711,360	1,010,540	1,356,280

1/ Pounds of 5-day biochemical oxygen demand per day.

runoff from rainfall or blown by winds is to be expected, possibly on the same order of magnitude (at least 10 percent) as for the loss of fertilizers.

Non-Organic Wastes

In WRPA 2 the non-BOD wastewater discharges from municipal, industrial and agricultural sources are not adequately quantified for discussion. However, present State and Federal discharge permit programs require water quality data which will define the quantities of the wastes that occur at these sources and that are subject to control.

Bacteria

The need for disinfection of sanitary wastes for the control of waterborne diseases, as discussed in the Regional Summary, is indicated in table 27 for WRPA 2.

Table 27 - Flows Containing Harmful Bacteria, WRPA 2

	1970	Program	1980	2000	2020
Flow1/	37.6	A	43.4	60.0	86.3
		B	46.9	67.3	100.7

1/ Millions of gallons of effluent per day.

EXISTING TREATMENT

Municipal and industrial organic waste treatment levels vary widely between communities and between industries. Average municipal sewage treatment for communities located in WRPA 2 are estimated at 80 percent in Arkansas and 80 percent BOD_5 removal in Missouri. Total municipal BOD_5 removed by existing treatment in 1970 was 43,220 pounds per day.

Average industrial organic waste treatment is estimated at 55 percent BOD_5 removal throughout the entire region, including WRPA 2. Total industrial BOD_5 removed by existing treatment in 1970 was 20,310 pounds per day.

Agricultural organic wastes are for the most part dispersed over wide areas and generally do not exist as point sources of pollution. Consequently, most wastes are subject to normal practices of land application generally beneficial to soils and crops, but subject to varying degrees of runoff from rainfall and snowmelt.

Disinfection of discharges for disease control are estimated at 10 percent in Arkansas and 5 percent in Missouri. The total chlorinated discharge in 1970 was 3.5 mgd.

WATER QUALITY CONTROL NEEDS

Water quality control needs exist wherever pollutants are discharged to water supplies. As stated under "Purpose," quantified needs herein are limited to organic or biodegradable wastes, and to bacteria. Organic pollutants are expressed in pounds of BOD_5 per day. Bacterial pollution is expressed in terms of flow in millions of gallons per day requiring treatment.

As explained in "Methodology," municipal and industrial waste loadings are considered point loadings to streams, whereas 95 percent of agricultural loadings are considered non-point sources of pollution. Projected net loadings to streams to the year 2020 are based on calculated total raw waste production minus the quantity of BOD removed or quantity of effluent disinfected by present (1970) treatment held as a constant through the projected 50-year period. Table 28 displays municipal and industrial organic pollution control needs. Table 29 displays pollution control needs for estimated agricultural point sources and table 30 shows needs for control of harmful bacteria.

The unsatisfied or net need shown in the 1970 column of the tables indicates that significant pollution control problems exist in WRPA 2 at the present time. The more notable of these problems areas are displayed on figure 3.

Only five percent of the total agricultural BOD waste production is estimated as entering the surface waters as point sources of pollution. The remaining organic wastes are disposed of by such methods as direct land application, recycling, aerated lagoon-irrigation systems, holding tanks, or some combination of these. Nonetheless, the wastes can cause an ultimate surface water problem unless proper land management practices are instituted and maintained.

Bacterial pollution may be persistent in stream reaches receiving nondisinfected effluent from population centers. In WRPA 2 effluent disinfection (chlorination) is not practiced extensively and by 2020 the problem may increase more than twofold if present levels of disinfection are maintained.

Table 28 - Municipal and Industrial Organic Pollution Control Needs, WRPA 2

Load Category	1970	Program	1980	2000	2020
		(Pounds of BOD_5)			
Municipal					
Total	54,020	A	61,860	82,400	113,380
Exstg. Trmt.	43,220		43,220	43,220	43,220
Net Need	10,800		18,640	39,180	70,160
		B	66,370	92,300	131,860
			43,220	43,220	43,220
			23,150	49,080	88,640
Industrial					
Total	36,920	A	44,670	77,530	151,000
Exstg. Trmt.	20,310		20,310	20,310	20,310
Net Need	16,610		24,360	57,220	130,690
		B	49,100	89,340	169,090
			20,310	20,310	20,310
			28,790	69,030	148,780
Total					
Total	90,940	A	106,530	159,930	264,380
Exstg. Trmt.	63,530		63,530	63,530	63,530
Net Need	27,410		43,000	96,400	200,850
		B	115,470	181,640	300,950
			63,530	63,530	63,530
			51,940	118,110	237,420

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Table 29 - Agricultural Organic Point Source Loads, WRPA 2

	1970	Program	1980	2000	2020
Waste Load 1/	24,280	A	28,200	37,060	48,290
		B	28,200	39,680	51,860

1/ Pounds or 5-day biochemical oxygen demand per day.

Table 30 - Bacterial Pollution Control Needs, WRPA 2

	1970	Program	1980	2000	2020
Total Discharge 1/	37.6	A	43.4	60.0	86.3
Chlorinated	3.5		3.5	3.5	3.5
Net Need	34.1		39.9	56.5	82.8
		B	46.9	67.3	100.7
			3.5	3.5	3.5
			43.4	63.8	97.2

1/ All figures are millions of gallons of effluent per day.

W R P A 3

STUDY AREA DESCRIPTION

General

In 1970 the West Tennessee-West Kentucky planning area (WRPA 3) was second only to the New Orleans planning area (WRPA 10) in terms of population. According to 1960 economic statistics, WRPA 3 was first in manufacturing and third in agricultural employment. It was the region's second largest producer of organic wastes from domestic and commercial sources in 1970, comprising 45 sewered communities of 1,000 or more inhabitants with a total population of 879,700 people. The WRPA ranked fifth in total organic wastewater production from industrial sources with 288 industries classified as producing biodegradable wastes in 1970. These industries generated organic wastes equivalent to those produced in an urban center of approximately 1.9 million people. WRPA 3 was third in total organic waste production from livestock and poultry. In 1970 this source produced organic wastes equivalent to an urban center of about 4.6 million people.

Water pollution problems in WRPA 3 include: (1) point source discharges of organic wastes that exceed the assimilative capacity of the receiving streams, (2) general bacteriological pollution from non-disinfected effluents, (3) indeterminate levels of pollution from agricultural organic wastes, fertilizers and pesticides, (4) untreated sewage discharging to the Mississippi River from Memphis, Tennessee (in 1970) and (5) scattered instances of ground-water pollution.

Population

WRPA 3 comprises 10,653 square miles in western Tennessee, southwestern Kentucky and the extreme southern tip of Illinois (see figure 6). In 1970 a total of 1,258,000 people inhabited the planning area and by 2020 the population is expected to increase to 2,569,000 and 2,983,000 according to the respective projections of Programs A and B. Crittenden County, Arkansas, although not a part of the hydrologic area cited above, is included in WRPA 3 because its waste production is part of the Memphis SMSA (Standard Metropolitan Statistical Area) which discharges to WRPA 1.

Of the total 1970 population of 1,258,000, the urban population was 881,000, or 70 percent of the total. The Memphis SMSA is the second largest metropolitan center in the region with a 1970 population of 770,120. Table 31 lists the total and urban populations of WRPA 3 for 1970 and the corresponding projected populations for 1980, 2000, and 2020 for Programs A and B.

Table 31 - Population, WRPA 3

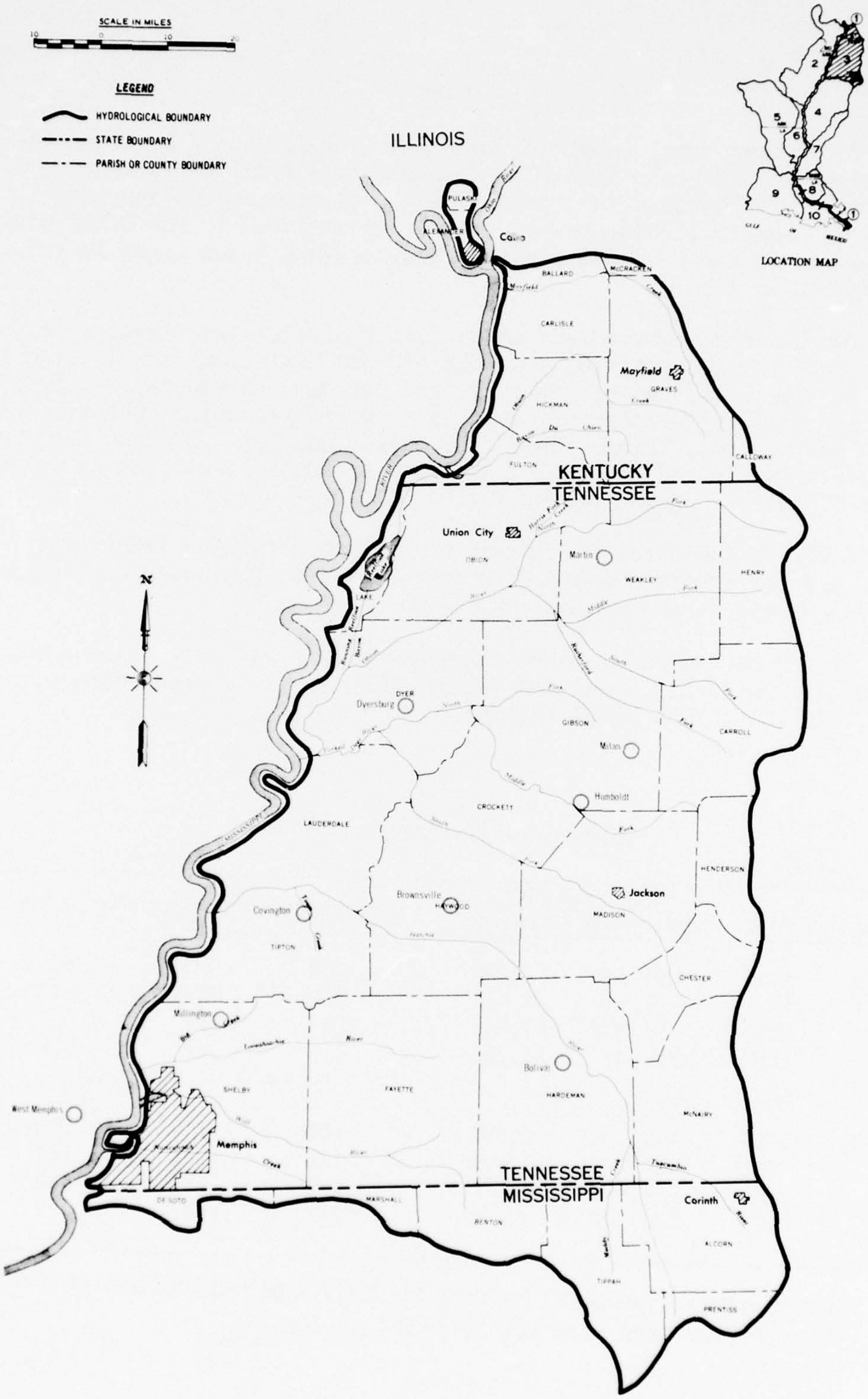
Base Population 1970	Programs	Projected Population 1980	2000	2020
Total Population 1,258,000	A	1,416,000	1,905,000	2,569,000
	B	1,555,000	2,166,000	2,983,000
Urban Population 881,000	A	1,062,000	1,562,000	2,261,000
	B	1,166,000	1,776,000	2,625,000

There are 14 communities of 5,000 or more inhabitants. These are listed alphabetically by State in table 32 (see figure 6). Memphis, Tennessee, is the largest community, with 623,530 inhabitants. In addition, there are 35 communities whose combined population of 84,600 ranges from 1,000 to 5,000 per community.

Table 32 - Principal Communities, WRPA 3

Community 1/	County	State	Community Population 1970
West Memphis 2/	Crittenden	Arkansas	25,892
Mayfield	Graves	Kentucky	10,724
Corinth	Alcorn	Mississippi	11,581
Bolivar	Hardeman	Tennessee	6,674
Brownsville	Haywood	"	7,011
Covington	Tipton	"	5,801
Dyersburg	Dyer	"	14,523
Humbolt	Gibson	"	10,066
Jackson	Madison	"	39,996
Memphis	Shelby	"	623,530
Milan	Gibson	"	7,313
Millington	Shelby	"	21,106
Union City	Obion	"	11,925
Martin	Weakley	"	7,781
Fourteen communities with a total population of:			803,923

1/ Incorporated places (cities, villages, towns, or boroughs) of 5,000 or more inhabitants.
2/ Part of Memphis, Tennessee SMSA.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WATER RESOURCE PLANNING
AREA 3

FIGURE 6

Economy

Total employment in WRPA 3 in 1968 was 490,191. This is an increase of 17.8 percent over 1960. By 2020 the total employment, according to Program A and B projections, is expected to increase to 1,037,000 and 1,223,000, respectively. As compared to the other planning areas in the Lower Mississippi Region, WRPA 3 was first in total employment in 1968.

Two hundred eighty-eight industries that yield wastewaters in relatively large quantities and high BOD concentrations are located in WRPA 3. The food, paper, chemicals and petroleum products industries comprise about 97 percent of the organic waste producing industries in the planning area. Among these four major industrial groups, food and kindred products and chemical and allied products industries comprise about 48 and 36 percent, respectively.

Table 33 indicates the growth of employment and of industrial water use for Programs A and B to the year 2020. The water use indexes are an average of the employment and earnings.

Mining operations involve nonmetallic minerals only. Among the nonmetallic minerals, sand and gravel ranks first in production with 2,631,000 short tons mined in 1969.

Table 33 - Employment, WRPA 3

		Major Industry		Indexes		
Program	Year	Employment	Earnings1/	Employment	Earnings	Water Use
A	1968	490,200	2,690	100	100	100
	1980	565,400	4,446	115	165	140
	2000	768,000	10,641	157	396	277
	2020	1,037,000	24,921	212	926	569
B	1968	490,200	2,690	100	100	100
	1980	620,000	4,874	126	181	154
	2000	888,000	12,306	181	457	319
	2020	1,223,000	29,393	249	1093	671

1/ In millions of dollars. Industrial water use indexes are an average of employment and earnings indexes.

Agricultural production reports of livestock and poultry place cattle and calves and hogs and pigs among the most numerous of large farm animals. In 1970 there were 597,800 cattle and calves and 388,600 hogs and pigs, ranking WRPA 3 second in the Lower Mississippi Region with respect to production of cattle and calves and first in production of hogs and pigs. Table 34 indicates the projected increase in production to the year 2020 for Programs A and B.

Table 34 - Numbers of Livestock and Poultry, WRPA 3

Livestock and Poultry	Numbers of Livestock and Poultry				
	1970	Program	1980	2000	2020
Cattle and Calves	597,800	A	761,400	1,024,900	1,376,400
		B	761,400	1,101,000	1,478,100
Milk Cows	53,800	A	49,400	61,000	74,500
		B	49,400	65,500	80,000
Hogs and Pigs	388,700	A	443,500	579,300	752,000
		B	443,500	622,300	807,600
Sheep and Lambs	15,900	A	12,200	14,300	17,700
		B	12,200	15,400	19,000
Chickens	1,626,600	A	1,787,000	2,287,500	2,897,600
		B	1,787,000	2,457,300	3,111,700
Broilers	1,278,100	A	1,782,600	2,489,000	3,341,600
		B	1,782,600	2,673,800	3,588,500
Turkeys	3,100	A	4,100	5,800	7,900
		B	4,100	6,200	8,400

Selected Streams

The Hatchie River, Obion River, Forked Deer Creek, Wolf River, and Mayfield Creek receive the largest organic waste loads discharged in WRPA 3. The flow of these streams is sustained largely by ground water seepage, by surface runoff from rainfall and to a very minor extent by snowmelt. Their waste assimilative capacities are least during periods of lowest streamflow, which generally occur in the months of August, September and October, with October frequently being the most critical month.

Appendix C contains a streamflow summary for selected sites in WRPA 3. Streamflow characteristics are affected by flow regulation and withdrawals for water supply. There is no regulation by dams in WRPA 3 except that provided by projects constructed under authority of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 566). The recorded flows range from a maximum momentary flow of 99,500 cfs on the Obion River at Obion, Tennessee, to a minimum momentary flow of zero cfs on the Wolf River. Zero flow is assumed to occur on numerous small streams throughout the planning area. Minimum annual flows range from 969 cfs on the Hatchie River at Bolivar, Tennessee, to 31 cfs on Mayfield Creek at Lovelaceville, Kentucky.

Surface water is used for irrigation and for fish and wildlife conservation in WRPA 3. One reservoir is under construction and will have a capacity of 5,000 acre-feet or more. A listing of reservoirs having a total capacity of 5,000 acre-feet or more is presented in Appendix C.

Major Aquifers

Ground water supplies in WRPA 3 are obtained from aquifers that comprise rock units of Quaternary, Tertiary, Cretaceous and Paleozoic age. Aquifers that yield major quantities of water for municipal, industrial and agricultural use are the McNairy Sand of Cretaceous age, and the Wilcox Formation and Memphis Aquifer of Tertiary age.

The water quality of these aquifers is discussed in the next section of this appendix. A listing of aquifers in WRPA 3 is presented as part of table 36 of that section. For details regarding the geology of the aquifers, see Appendix C.

PRESENT STATUS

Water Use

Water use for municipal supply, industry and irrigation totalled 268.5 mgd in 1970. Municipal supply accounted for 141.8 mgd (52.8 percent), industrial use for 98.0 mgd (36.5 percent) and irrigation for 28.7 mgd (10.7 percent) of this total. As compared to the other planning areas, WRPA 3 was seventh in total water use. By 2020 it is expected that water use for Programs A and B will increase by 188 percent and 235 percent respectively, for municipal supply, by 717 and 864 percent for industry and 261 and 298 percent for irrigation.

Cooling water used for thermal electric power generation totalled 430 mgd in 1970, and thus constituted the largest water withdrawal in WRPA 3. As compared to the other planning areas, WRPA 3 ranked fourth in total thermal electric cooling water requirements. By 2020 it is expected that this water use will increase 361 percent for Program A and 435 percent for Program B.

Water Quality

Surface Water

In WRPA 3 water analyses are available on Mayfield Creek, South Fork of the Forked Deer River, North Fork of the Forked Deer River, Hatchie River and Wolf River. Selected analyses of water sampled under relatively high and low streamflow are listed for these major streams in table 35.

These streams have calcium bicarbonate waters with maximum recorded concentrations of 7.9 mg/1 calcium and 34 mg/1 bicarbonate. The maximum dissolved solids, sulfate, and chloride concentrations are 372, 11 and 20 mg/1, respectively, indicating that in terms of these three parameters and in relation to their recommended limiting concentrations for drinking water, the streams are of acceptable quality.

Ground Water

In WRPA 3 analyses of ground water are available from aquifers of Quaternary, Tertiary, Cretaceous and Paleozoic ages. The analyses listed in table 36 represent ranges in chemical composition of well water from each aquifer as based on maximum and minimum concentrations of dissolved solids, sulfate and chloride.

Most aquifers that yield water meeting the recommended limiting concentrations for drinking purposes yield water of the calcium bicarbonate type. Exceptions to this are parts of the Quaternary Alluvium, Terrace deposits, undifferentiated Holocene Alluvium, undifferentiated Eocene series, and the Claiborne Formation which yield bicarbonate

Table 35 - Stream Quality, WRPA 3

Stream Sampling Station 1/	Date of Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/1)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/1)	Temp. °C
Mayfield Cr. at Lovelaceville, Kentucky	9-12-61 8-3-61	16 21	6.6 5.2	2.3 1.9	34 31	8.7 10	2.0 2.8	8.0 7.6	7.0 5.3	1.8 1.1	77 60	96 84	6.5 6.5		
South Fork of the Forked Deer River at Jackson, Tennessee	12-17-64 6-11-68	738 136	3.2 3.2	1.7 1.1	12 15	2.8 3.2	1.4 0.9	8.2 3.8	2.4 2.9	0.2 2.6	74 36	52	7.1 6.8		
North Fork of the Forked Deer River at Trenton, Tennessee	3-10-65 10-14-64	48.6	4.7 2.9	2.3 1.2	19 22	5.0 3.3	1.6 0.9	11 0.0	4.2 0.6	1.4 0.0	60 29	78 44	6.6 7.2		
Hatchie River at Bolivar, Tennessee	6-11-68	425	7.9	1.9	22	10	1.2	8.5	15	2.4	76		6.7		
Hatchie River Mile 100.1 (Bolivar)	6-7-62 10-18-62	1,620 391							8 20		290 88		6.9 6.7	6.1 6.6	25 19
Hatchie River Mile 109.3	6-6-62 10-16-62								7 5		372 52		7.1 7.0	6.1 5.5	24 22
Wolf River at Rossville, Tennessee	4-27-67 12-10-65	3,010 185	3.4 1.8	1.2 0.8	16 12	2.5 3.8	2.9 0.0	4.1 1.0	3.2 1.3	0.5 0.0	79 30	47 36	6.4 6.5		
Wolf River at Raleigh, Tennessee	7-19-64	272	2.8	0.0	18	3.0	1.0	0.4	2.0	0.3	25	40	6.5		

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

Table 36 - Ground-Water Quality, WRPA 3 1/

Aquifer System	Well No.	Well Depth (ft.)	Date of Collection	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH	Temperature (°C)
Quaternary															
Alluvium	1	33	6-12-58	165	43	698	12	7.7	26	8	2.5	652	980	7.1	17
	2	100	4-29-55	7.6	0.5	69	7.2	0.2	2.5	1.5	3.8	102	121	6.8	19
Alluvium Along Mississippi R. and Ohio River	3	31	8-5-66			715			73	8	0.8	707	1110	8.4	14
	4	78	10-22-63	19	0.4	73	8.9	0.7	3.6	5.5	0.9	94	140	6.3	14
Terrace	5	20	1-15-53	77	24	76	30	27	257	33	4.2	533	747	6.8	14
	6	8	7-22-53	3.8	1.1	19	4.1	1.2	0.8	5.5	1.0	23	48	5.9	20
Holocene Alluvium Undifferentiated	7	38	5-9-67	149	31	640	6	3	0.8	5	0.1	547	923	6.9	14
	8	35	6-18-65	13	2.5	83	19	0.5	3.2	4.5	13	113	169	6.6	
Pliocene-Pleistocene Continental deposits	9	37	10-14-66			644			136	354	27	1380	2140	7.4	16
	10	60	1-4-54	7.0	2.2	28	11	0.9	1.1	14	8	69	113	6.3	
Tertiary															
Eocene Series, Undifferentiated	11	260	9-29-67	8.1	3.2	26	13	0.8	22	12	8.2	101	154	6.0	
	12	260	10-18-66	5.9	2.2	20	9.6	0.6	15	7.5	4.8	69	109	5.9	15
Clairborne Formation	13	84	10-14-66			644			24	50	72	760	1160	6.9	17
	14	225	9-27-61	1.3	0.7	10	1.9	0.4		1.2	0.6	19	23	6.0	
Wilcox Formation	15	241	8-6-65	16	3.1	130	32	58	17	2.2	0.4	173	240	6.5	19
	16	100	5-4-60	6.6	2.6	19			1.2	17		20	141		
Clayton Formation	17	70	1-14-53	74	80	0.0	22	7.8	652	7	0.6	1060	1210	3.9	16
	18	1200	1-8-63	6.7	2.5	466	165	6.8	6	1.0	0.6	472	661	8.2	
Cretaceous															
Ripley Formation	19	147	2-23-60			204				3		205	299	8.2	16
	20	150	12-2-54	50	8.8	186	3.4	1.9	6.8	5.0	0.0	190	342	8.0	17
McNairy Sand Member	21	2650	9-26-27	3.2	1.0	925	432.2		1.8	16.5	0.0	1026		7.8	29
	22	252	10-18-62	2.5	0.4	13	1.6	0.5	0.0	1.0	0.0	22	32	5.8	
Coffee Sand	23	300	10-1-56	152	7.5	384	13	2.6	75	38	0.4	495	761	7.7	
	24	90	9-29-56	5.8	1.8	22	1.7	1.6	6.6	1.5	0.2	48	65	6.1	18
Eutaw Formation (unrestricted)	25	285	12-4-67	53	7	196	2.3	2.6	10	2.4	0.0	196	323	7.6	17
	26	350	10-3-63	8	1.9	32	3.9	1.8	7.6	3.6	0.1	81	86	6.1	19
Eutaw Formation (restricted)	27	600	3-15-46	48	19	209	13		47	4.2	1.2	246	409	7.9	18
	28	600	6-14-51	48	17	199	6.1	1.0	36	3.0	1.1	235	375	7.6	
Paleozoic	29	375	5-21-51	36	9.6	141	77	8.5	15	125	0.3	358	358	7.6	
	30	493	10-4-56	25	5.3	110	10	2.8	9.4	5.5	0.2	113	212	7.6	

1/ Contrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

waters with approximately equal concentrations of calcium and sodium. Parts of the Wilcox Formation, the McNairy Sand Member and undifferentiated Paleozoic rocks yield sodium bicarbonate type water.

As indicated in table 36, several aquifers or portions of aquifers yield water exceeding the recommended limiting concentrations for drinking water. The maximum concentrations of these waters range in dissolved solids from 533 mg/l (Terrace deposits) to 1,380 mg/l (continental deposits), in sulfate from 257 mg/l (Terrace deposits) to 652 mg/l (Clayton Formation) and in chloride (only in a single sample) 354 mg/l (continental deposits). Calcium sulfate water is the most common type among these aquifers containing excessively mineralized waters. Aquifers that can yield highly mineralized water include the Quaternary Alluvium, alluvium along the Mississippi and Ohio Rivers, Terrace deposits, Holocene alluvium, continental deposits, Claiborne Formation, Clayton Formation, and the McNairy Sand Member.

Appendix C shows the altitude of the base of fresh water in the Coastal Plain aquifers of the region. In WRPA 3 the base of fresh water ranges from about 0 to more than 2,000 feet below sea level.

The recent U.S. Geological Survey study of the occurrence of ground-water pollution (4) discusses three sites in WRPA 3. The pollutants are hydrogen cyanide, gasoline, and chlorinated hydrocarbons. Figure 2 shows the location of reported areas of ground-water pollution.

In Carlisle County, Ky., about one-half mile north of Arlington, liquid wastes discharged by a pottery were reported in 1968 to contain hydrogen cyanide. Water from wells at the pottery contained 0.13 mg/l cyanide in 1967. Since 1961 the toxicity of the cyanide effluent has been reduced by treatment with chloroform. The aquifer affected is a shallow Eocene formation.

At Memphis, Tenn., gasoline from a leaky underground storage tank at a service station filtered downward to the water table and moved downgradient. One private well produced several gallons per day of refined gasoline in 1951. The tank was replaced by the service station owner. The aquifer affected is composed of terrace gravel deposits.

At Toone, Hardeman County, Tenn., chlorinated hydrocarbons from buried pesticide wastes exposed approximately 200 acres to potential pollution in 1967. The industrial land fill was dug into a shallow water table aquifer composed of unconsolidated sand.

Two sites in WRPA 3 exist where pollution and deteriorating water quality result from natural conditions. The pollution involves high iron concentrations and high mineralization.

At Jackson, Tenn., ground water from a deep artesian aquifer contains iron in high concentrations. In 1950 this water was reported to

have gained entry into a shallow artesian aquifer used as a principal source of municipal water supply. Casing failures in abandoned wells screened in the deep aquifer are thought to be the main reason for this pollution. Treatment facilities to remove iron have been installed to improve the quality of the municipal water supply.

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

Municipal

WRPA 3 has 45 sewered communities of 1,000 or more inhabitants. The total population served in 1970 is estimated at 879,700, as shown in table 37. The total daily raw waste production is 158,350 pounds of BOD. According to Programs A and B, the sewered population is expected to be 2,012,900 and 2,337,000 by 2020, which are increases of 129 and 166 percent, respectively. Correspondingly, the total raw BOD waste production will increase to 402,580 pounds per day by 2020 for Program A and to 467,400 for Program B.

Of the 45 sewered communities with 1,000 or more inhabitants, there are 31 (69 percent of the WRPA total) that have less than 5,000 inhabitants. The total sewered population of these smaller communities is 75,800 or 9 percent of the total for WRPA 3. The average raw waste production per community is 440 pounds of BOD per day. Five communities (11 percent) are in the range of 5,000 to 9,900 inhabitants and have a total sewered population of 34,600 or 4 percent of the WRPA total. The average raw waste production per community is 1,246 pounds of BOD per day. Eight communities (18 percent) are in the range of 10,000 to 49,900 inhabitants and comprise a sewered population of 145,800 or 17 percent of the total for WRPA 3. The average raw waste production per community is 3,281 pounds of BOD per day. One community (2 percent) is in the range of 100,000 or more inhabitants and has a sewered population of 623,500 or 71 percent of the WRPA total. The raw waste production is 112,230 pounds of BOD_5 per day.

Many of the sewered communities discharge their effluent to small streams that seasonally have little or no flow. As a consequence, even secondary treatment of sewage may be inadequate and local water quality problems may arise.

Industrial

In 1970 there were 288 industries classified as producing biodegradable wastes in WRPA 3. Major categories involved in this waste production were Food and Kindred Products (48 percent of the total number of industries in WRPA 3), Chemical and Allied Products (36 percent), Paper and Allied Products (9 percent), Petroleum and Coal Products (4 percent) and Rubber and Plastics Products (1 percent).

Industrial waste production is relatively large in WRPA 3. The 288 industries inventoried are located in or near 32 communities with Memphis, Humboldt, Jackson, and Bolivar, Tennessee, being the largest centers. In 1970 the combined municipal (domestic and commercial) and industrial loads discharged to the Mississippi River from Memphis were

about 161,600 pounds of BOD_5 per day. The combined municipal and industrial loads discharged from the Humboldt area to Middle Fork Forked Deer Creek, from Jackson to the South Fork Forked Deer Creek, and from Bolivar to the Hatchie River were 37,618, 8,478, and 6,527 pounds of BOD_5 per day. The principal industries that produce organic wastes in the Memphis area are in food processing and chemical products. In the Humboldt and Jackson areas food processing is by far the predominant type of industry producing organic wastes. In the Bolivar area the leather products and food processing industries produce most of the organic wastes.

As shown in table 37, the industrial population equivalent for 1970 is expected to increase from 1,944,300 to 9,956,900 and 10,114,400 by 2020 according to Programs A and B. The corresponding raw BOD waste load before treatment of 349,980 pounds per day in 1970 is projected to be 1,991,380 pounds per day by 2020 for Program A and 2,022,870 for Program B.

Agricultural

Among the seven categories of farm animals listed in table 34, cattle and calves is the largest in terms of waste production, accounting for 73 percent of the daily total. Turkeys is the smallest category and totals 0.02 percent of the total waste production.

The total daily raw organic wastes produced by livestock and poultry in WRPA 3 in 1970, and estimated for the projected years, is indicated in table 38. As explained in the regional Summary, agricultural animal wastes generally constitute a non-point source of pollution in the Lower Mississippi Region.

The total daily production of organic wastes from livestock and poultry in 1970 was 823,800 pounds of BOD_5. For Programs A and B this total is expected to increase to 1,773,600 and 1,904,600, respectively, by the year 2020.

The land area in WRPA 3 affected by erosion in 1970 totalled more than 60 percent and ranged from 15 percent along Forked Deer Creek to 70 percent in the Wolf River Basin. The average gross erosion of the affected areas was 13.3 tons per acre/year and ranged from 7.2 in the Hatchie River Basin to 25.7 tons per acre/year in the Forked Deer Creek Basin.

The use of fertilizers on extensive tracts of cultivated land is a significant potential source of nutrients that can be lost by runoff and wind and carried to the streams. Little information is available on this loss of fertilizers; however, it would appear that 10 percent may be a realistic low estimate. In 1969 the use of fertilizers in WRPA 3 totalled 232,173 tons, which were applied to 1,373,680 acres. This averages 338 pounds of fertilizers per acre per year.

Table 37 - Municipal and Industrial Organic Waste Production, WRPA 3

Load Category	Daily Raw Organic Waste Production 1970	Program	1980	2000	2020
Municipal					
P.E. 1/	879,700	A	1,013,700	1,442,300	2,012,900
		B	1,113,000	1,639,500	2,337,000
#BOD 2/	158,350	A	192,600	288,460	402,580
		B	211,470	327,900	467,400
Industrial					
P.E.	1,944,300	A	2,578,800	4,847,200	9,956,900
		B	2,836,700	5,547,200	10,114,400
#BOD	349,980	A	489,970	969,440	1,991,380
		B	538,970	1,109,430	2,022,870
Total					
P.E.	2,824,000	A	3,592,500	6,289,500	11,969,800
		B	3,949,700	7,186,700	12,451,400
#BOD	508,330	A	682,570	1,257,900	2,393,960
		B	750,440	1,437,330	2,490,270

1/ P.E. - Population equivalents: See Methodology.

2/ #BOD - Pounds of 5-day biochemical oxygen demand per day.

Table 38 - Organic Wastes from Livestock and Poultry, WRPA 3

	1970	Program	1980	2000	2020
BOD_5 1/	823,759	A	1,003,545	1,336,378	1,773,625
		B	1,003,545	1,435,563	1,904,672

1/ Pounds of 5-day biochemical oxygen demand per day.

may be a realistic low estimate. In 1969 the use of fertilizers in WRPA 3 totalled 232,173 tons, which were applied to 1,373,680 acres. This averages 338 pounds of fertilizers per acre per year.

There are no compiled figures on the quantities of agricultural pesticides used in the Lower Mississippi Region. However, insecticides and herbicides are applied by aerial and land spraying or dusting. The loss of significant quantities of pesticides carried to streams by runoff from rainfall or blown by winds is to be expected, possibly on the same order of magnitude (at least 10 percent) as for loss of fertilizers.

Non-Organic Wastes

In WRPA 3 the non-BOD wastewater discharges from municipal, industrial and agricultural sources are not adequately quantified for discussion. However, present State and Federal discharge permit programs require water quality data which will define the quantities of the wastes that occur at these sources and that are subject to control.

Bacteria

The need for disinfection of sanitary wastes for the control of waterborne diseases, as discussed in the Regional Summary, is indicated in table 39 for WRPA 3.

Table 39 - Flows Containing Harmful Bacteria, WRPA 3

	1970	Program	1980	2000	2020
Flow 1/	115.0	A	141.1	216.8	308.2
		B	154.8	246.1	357.2

1/ Millions of gallons per day.

EXISTING TREATMENT

Municipal and industrial organic waste treatment levels vary widely between communities and between industries. Average municipal sewage treatment for communities located in WRPA 3 are estimated at 70 percent in Kentucky, 75 percent in Tennessee, 80 percent in Arkansas, and 50 percent BOD_5 removal in Mississippi. Not included in the average for Tennessee was Memphis, which in 1970 discharged raw sewage to the Mississippi River. Secondary treatment facilities are now under construction. Total municipal BOD_5 removed by existing treatment in 1970 was 33,990 pounds per day.

Average industrial organic waste treatment is estimated at 55 percent BOD_5 removal throughout the entire region, including WRPA 3. Total industrial BOD_5 removed by existing treatment in 1970 was 192,490 pounds per day.

Agricultural organic wastes are for the most part dispersed over wide areas and generally do not exist as point sources of pollution. Consequently, most wastes are subject to normal practices of land application generally beneficial to soils and crops, but subject to varying degrees of runoff from rainfall on snowmelt.

Disinfection of discharges for disease control are estimated at 90 percent in Kentucky, 100 percent in Tennessee (exclusive of Memphis), 10 percent in Arkansas and 30 percent in Mississippi. The total chlorinated discharge in 1970 was 27.3 mgd.

WATER QUALITY CONTROL NEEDS

Water quality control needs exist wherever pollutants are discharged to water supplies. As stated under "Purpose", quantified needs herein are limited to organic, or biodegradable wastes, and bacteria. Organic pollutants are expressed in pounds of BOD_5 per day. Bacterial pollutants are expressed in terms of flow in m.g.d. requiring treatment.

As explained in "Methodology" municipal and industrial waste loadings are considered point loadings to streams, whereas 95 percent of agricultural loadings are considered non-point sources of pollution. Projected net loadings to streams to the year 2020 are based on calculated total raw waste production minus the quantity of BOD or bacteria removed by present (1970) treatment held as a constant through the projected 50-year period. Table 40 displays municipal and industrial organic pollution control needs. Table 41 displays pollution control needs for estimated agricultural point sources, and table 42 shows needs for control of harmful bacteria.

The unsatisfied or net need shown in the 1970 column of the tables indicates that significant pollution control problems exist in WRPA 3 at the present time. The more notable of these problem areas are displayed on figure 3.

Only five percent of the total agricultural BOD waste production is estimated as entering the surface waters as point sources of pollution. The remaining organic wastes are disposed of by such methods as direct land application, recycling, aerated lagoon-irrigation systems, holding tanks, or some combination of these. Nonetheless, the wastes can cause an ultimate surface water problem unless proper land management practices are instituted and maintained.

Bacterial pollution is probably persistent in stream reaches receiving nondisinfected effluent from population centers. In WRPA 3 effluent disinfection (chlorination) is practiced extensively. By 2020 the need may increase more than threefold if present levels of disinfection are maintained.

Table 40 - Municipal and Industrial Organic Pollution Control Needs, WRPA 3

Load Category	1970	Program	1980	2000	2020
		(Pounds of BOD_5)			
Municipal					
Total	158,350	A	192,600	288,460	402,580
Exstg. Trmt.	33,990		33,990	33,990	33,990
Net Need	124,360		158,610	254,470	368,590
		B	211,470	327,900	467,400
			33,990	33,990	33,990
			177,480	293,910	433,410
Industrial					
Total	349,980	A	489,970	969,440	1,991,380
Exstg. Trmt.	192,490		192,490	192,490	192,490
Net Need	157,490		297,480	776,950	1,798,890
		B	538,970	1,109,430	2,022,870
			192,490	192,490	192,490
			346,480	916,940	1,830,380
Total					
Total	508,330	A	682,570	1,257,900	2,393,960
Exstg. Trmt.	226,480		226,480	226,480	226,480
Net Need	281,850		456,090	1,031,420	2,167,480
		B	750,440	1,437,330	2,490,670
			226,480	226,480	226,480
			523,960	1,210,850	2,264,190

Table 41 - Agricultural Organic Point Source Loads, WRPA 3

	1970	Program	1980	2000	2020
Waste Load 1/	38,900	A	44,070	57,540	74,670
		B	44,070	61,810	80,190

1/ Pounds of 5-day biochemical oxygen demand per day.

Table 42 - Bacterial Pollution Control Needs, WRPA 3

	1970	Program	1980	2000	2020
Total Discharge 1/	115.0	A	141.1	216.8	308.2
Chlorinated	27.3		27.3	27.3	27.3
Net Need	87.7		113.8	189.5	280.9
		B	154.8	246.1	357.2
			27.3	27.3	27.3
			127.5	218.8	329.9

1/ All figures are millions of gallons of effluent per day.

W R P A 4

STUDY AREA DESCRIPTION

General

In 1970 the Yazoo planning area (WRPA 4) was fifth in population within the Lower Mississippi Region. According to 1960 economic statistics, WRPA 4 was sixth in manufacturing and first in agricultural employment. It was the region's seventh largest producer of organic wastes from domestic and commercial sources in 1970, comprising 43 sewered communities of 1,000 or more inhabitants with a total population of 258,200 people. The WRPA ranked eighth in total organic wastewater production from industrial sources with 84 industries classified as producing biodegradable wastes in 1970. These industries generated organic wastes equivalent to those produced in an urban center of approximately 0.5 million people. WRPA 4 was second in total organic waste production from livestock and poultry. In 1970 this source produced organic wastes equivalent to an urban center of about 5.0 million people.

Water pollution problems in WRPA 4 include: (1) point source discharges of organic wastes that exceed the assimilative capacity of the receiving streams, (2) indeterminate levels of pollution from agricultural organic wastes, fertilizers and pesticides, (3) general bacteriological pollution from non-disinfected effluents, and (4) a few instances of ground-water pollution.

Population

WRPA 4 comprises 13,355 square miles in the northwestern part of Mississippi (see figure 7). In 1970 a total of 638,000 people inhabited the planning area and by 2020 the population is expected to increase to 828,000 and 941,000 according the respective projections of Programs A and B.

Of the total 1970 population of 638,000, the urban population was 236,000, or 37 percent of the total. Table 43 lists the total and urban populations of WRPA 4 for 1970 and the corresponding projected population for 1980, 2000, and 2020 for Programs A and B.

There are 12 communities of 5,000 or more inhabitants. These are listed alphabetically by State in table 44 (see Figure 7). Greenville, Mississippi, with 39,648 inhabitants, is the largest community. In addition, there are 38 communities whose combined population of 80,500 people ranges from 1,000 to 5,000 per community.

Table 43 - Population, WRPA 4

Base Population 1970	Programs	Projected Population 1980	2000	2020
Total Population				
	A	635,000	701,000	828,000
638,000	B	693,000	795,000	941,000
Urban Population				
	A	260,000	343,000	464,000
236,000	B	284,000	390,000	527,000

Table 44 - Principal Communities, WRPA 4

Community 1/	County	State	Community Population 1970
Cleveland	Bolivar	Mississippi	13,327
Clarksdale	Coahoma	"	21,673
Grenada	Grenada	"	9,944
Oxford	Lafayette	"	13,846
Greenwood	Leflore	"	22,400
Holly Springs	Marshall	"	5,728
Indianola	Sunflower	"	8,947
New Albany	Union	"	6,426
Vicksburg	Warren	"	25,478
Greenville	Washington	"	39,648
Leland	Washington	"	6,000
Yazoo City	Yazoo	"	10,796
Twelve communities with a total population of:			184,213

1/ Incorporated places (cities, villages, towns, or boroughs) of 5,000 or more inhabitants.

LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WATER RESOURCE PLANNING
AREA 4

FIGURE 7

Economy

Total employment in WRPA 4 in 1968 was 231,004. This is an increase of 10.8 percent over 1960. By 2020 the total employment, according to Programs A and B projections, is expected to increase to 319,000 and 376,000 respectively. As compared to the other planning areas in the Lower Mississippi River Basin Study, WRPA 4 was fifth in total employment in 1968.

Eighty-four industries that yield wastewaters in relatively large quantities and high BOD concentrations are located in WRPA 4. Food, paper, chemicals and petroleum products industries comprise about 99 percent of the organic waste producing industries in the planning area. Among these four major industrial groups, food and kindred products and chemical and allied products industries comprise about 73 and 20 percent, respectively.

Table 45 indicates the growth of employment and of industrial water use for Program A and B to the year 2020. The water use indexes are an average of the employment and earnings.

Mining operations include fuels and nonmetallic minerals. Natural gas and petroleum are the principal fuels mined. Production figures for natural gas are 112 million cubic feet and petroleum production of 2,694,000 barrels. Among the nonmetallic minerals, sand and gravel ranks first in production at 3,451,000 short tons mined in 1969.

Agricultural production reports of livestock and poultry place cattle and calves and hogs and pigs among the most numerous of large farm animals. In 1970 there were 695,300 cattle and calves and 181,600 hogs and pigs, ranking WRPA 4 first in the Lower Mississippi Region with respect to production of cattle and calves and third in production of hogs and pigs. Table 46 indicates the projected increase in production to the year 2020 for Programs A and B.

Selected Streams

The Yazoo River, Sunflower River, Deer Creek, Yalobusha River and Tallahatchie River receive the largest organic waste loads discharged in WRPA 4. The flow of these streams is sustained largely by groundwater seepage, by surface runoff from rainfall and to a minor extent by snowmelt. Their waste assimilative capacities are least during periods of lowest streamflow, which generally occur in the months of August, September and October with October frequently being the most critical month.

Appendix C contains a streamflow summary for selected sites in WRPA 4. Streamflow characteristics are affected by flow regulation and withdrawals for water supply. The recorded streamflows range from a maximum

Table 45 - Employment, WRPA 4

Program	Year	Major Industry Employment	Major Industry Earnings 1/	Indexes Employment	Indexes Earnings	Indexes Water Use
A	1968	231,000	974	100	100	100
	1980	227,000	1,370	98	141	120
	2000	261,000	2,942	113	302	208
	2020	319,000	6,638	138	682	410
B	1968	231,000	974	100	100	100
	1980	249,000	1,502	108	154	131
	2000	302,000	3,402	131	349	240
	2020	376,000	7,829	163	804	484

1/ In millions of dollars. Industrial water intake indexes are an average of employment and earnings indexes.

Table 46 - Numbers of Livestock and Poultry, WRPA 4

Livestock and Poultry	1970	Program	1980	2000	2020
Cattle and Calves	695,300	A	885,500	1,192,000	1,600,900
		B	885,500	1,280,500	1,719,100
Milk Cows	46,100	A	42,300	52,300	63,800
		B	42,300	56,100	68,500
Hogs and Pigs	181,600	A	270,200	270,700	351,400
		B	270,200	290,800	377,400
Sheep and Lambs	14,200	A	10,900	12,800	15,800
		B	10,900	13,800	16,900
Chickens	2,091,900	A	2,298,200	2,941,800	3,726,500
		B	2,298,200	3,160,200	4,001,800
Broilers	5,929,500	A	8,269,900	11,547,100	15,502,700
		B	8,269,900	12,404,400	16,648,000
Turkeys	5,900	A	7,900	11,100	15,000
		B	7,900	11,900	16,100

momentary flow of 61,400 cfs on the Skuna River at Bruce, Mississippi, to a minimum momentary flow of 0 cfs on Cane Creek near New Albany, Mississippi, and 0 cfs on the Yalobusha River at Calhoun City, Mississippi. Zero flow is assumed to occur on numerous small streams throughout the planning area. Minimum annual flows range from 5,062 cfs on the Yazoo River at Greenwood, Mississippi, to 9 cfs on Clear Creek near Oxford, Mississippi.

Major water withdrawals are for power production and irrigation. There are four large reservoirs in WRPA 4. These reservoirs are for flood control and recreation and include the Arkabutla on Coldwater River, Sardis on Little Tallahatchie River, Enid on Yocona River and Grenada Reservoir on Yalobusha River. Further information on streamflow is available from Appendix C, which lists the reservoirs with a total capacity of 5,000 acre-feet or more.

Major Aquifers

Ground water supplies in WRPA 4 are obtained from aquifers that comprise rock units of Quanternary, Tertiary and Cretaceous age. Aquifers that yield major quantities of water for municipal, industrial and agricultural use are the Quaternary alluvium, the Meridian-Upper Wilcox, Sparta Sand, and Cockfield Formation of Tertiary age.

The water quality of these aquifers is discussed in the next section of this appendix. A listing of aquifers in WRPA 4 is presented as part of table 48 of that section. For details regarding the geology of the aquifers, see Appendix C.

PRESENT STATUS

Water Use

Water use for municipal supply, industry and irrigation totalled 436.2 mgd in 1970. Municipal supply accounted for 53.8 mgd (12.3 percent), industrial use for 86.6 mgd (19.9 percent) and irrigation for 295.8 mgd (67.8 percent) of this total. As compared to the other planning areas, WRPA 4 was sixth in total water use. By 2020 it is expected that water use for Program A (and Program B) will increase by 130 percent (161 percent for Program B) for municipal supply, by 742 percent (893 percent) for industry and 42 percent (76 percent) for irrigation.

Cooling water used for thermal electric power generation totalled 305.0 mgd in 1970, and thus constituted the largest water demand in WRPA 4. As compared to the other planning areas WRPA 4 ranked seventh in total thermal electric cooling water requirements. By 2020 it is expected that this water use will increase 263 percent for Program A and 412 percent for Program B.

Water Quality

Surface Water

In WRPA 4 water analyses are available on the Sunflower River and the Yazoo River. Selected analyses of water sampled under relatively high and low stream flow are listed for these streams in table 47.

These streams have calcium bicarbonate waters with maximum recorded concentrations of 56 mg/l calcium and 277 mg/l bicarbonate. These streams are of generally good quality with maximum dissolved solids, sulfate and chloride concentrations of 272, 16 and 19 mg/l, respectively. As indicated in table 127, the recommended limiting concentrations of dissolved solids, sulfate and chloride for drinking water are 500, 250, and 250 mg/l, respectively.

Ground Water

In WRPA 4 analyses of ground water are available from aquifers of Quaternary, Tertiary and Cretaceous age. The analyses listed in table 48 represent ranges in chemical composition of well water from each aquifer as based on maximum and minimum concentrations of dissolved solids, sulfate and chloride.

Of the 32 wells represented in table 48, a total of 21 yield water meeting the recommended limiting concentrations for drinking purposes. Thirteen of these wells yield water of the sodium bicarbonate type; the remainder are of the calcium bicarbonate type. Several aquifer systems represented in table 48 yield both types of water. These include the Forest Hill Sand, the Cockfield Formation, the Wilcox Group and the Eutaw Formation (unrestricted), depending upon the depth of withdrawal.

Table 47 - Stream Quality, WRPA 4

Stream Sampling Station 1/	Date of Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/l)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/l)	Temp. °C
Yazoo River at Greenwood, Mississippi	9-29-66	171	11	4.7	62	8.0	3.0	10	4.2	1.4	87	132	6.8		
	4-12-65	18,600	4.2	1.3	18	2.5	1.9	6.2	1.5	0.3	33	57	5.8		
Sunflower River at Sunflower, Mississippi	6-28-67	144	56	16	277	24	1.5	16	12	0.1	272	478	7.0		
	1-6-67	1,160	12	4.0	52	5.4	4.6	10	3.4	3.5	101	129	6.7		
Yazoo River at Redwood, Mississippi	11-1-61		27	7.2	128	19	2.0	8.8	19	0.2	174	265	7.0		
	3-22-62		4.0	2.7	24	4.9	2.2	4.6	7.0	0.0	43	74	6.6		

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

Table 48 - Ground-Water Quality, WRPA 4

Aquifer System	Well No.	Well Depth (ft.)	Date of Collection	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH	Temperature (°C)
Quaternary															
Pleistocene															
Mississippi River Alluvial Aquifer	1	58	8-21-11	174	6.1	879	143	0.0	46	11	1.0	883			
	2	30	7-10-68	54	16	216	8.4	0.3	24	58	12.0	248	416	7.6	18
Tertiary															
Oligocene															
Vicksburg Group															
Forest Hill Sand	3	137	3-16-62	74	10	431	64	7.0	1.2	5.5	0.9	430	738	8.2	
	4	260	3-16-62	38	15	306	47	2.6	0.2	5.1	0.1	332	463	8.2	21
Eocene															
Clairborne Group															
Cockfield Formation	5	609	12-08-70	7.4	1.8	700	1000	8.2	3.8	1170	0.0	2700	4610	8.2	
	6	433	5-28-58	28	8.0	172	23	4.5	3.2	8.0	1.1	203	274	8.1	23
Sparta Sand	7	890	4-10-69	2.6	1.3	592	755	17	0.4	860	1.5	1960	1560	8.0	24
	8	300	3-3-71	3.8	1.6	26	7.4	0.6	2.2	5.8	0.5	50	68	6.0	
Winona Sand	9	933	4-13-64	0.3	0.3	557	212	1.4	0.0	3.2	0.2	543	802	8.1	23
Tallahatta Formation	10	1924	8-12-11	12	12	1552	651	0.0	29	12	0.5	1591			
	11	900	3-2-71	8.7	4.0	55	4.4	0.8	3.6	1.7	0.0	60	94	6.3	
Meridian Sand Member	12	1682	11-19-63	1.3	0.0	456	194	1.7	0.2	5.0	0.3	505	798	8.9	26
	13	86	8-15-58	2.2	0.7	10	4.2	1.1	3.6	4.8	1.0	48	48	5.7	18
Tallahatta Siltstone															
Meridian-Upper Wilcox Aquifer	14	1900	2-1-56	5.1	0.6	1300	1060	13	3.8	860	1.5	2680	4490	7.9	34
	15	347	3-3-71	1.8	0.9	12	3.2	0.5	1.4	2.0	1.5	41	29	5.8	
Wilcox Group	16	1516	2-5-40	1.0	0.2	477	181	3.4	1.6	10	0.0	473	473		
	17	344	11-25-58	14	4.7	24	15	4.1	20	26	17	158	212	6.8	
Tuscahoma Formation															
Middle Wilcox Formation	18	517	8-27-19	4.4	1.0	334	218	0.0	3.3	140	1.2	553			21
	19	320	8-27-19	3.7	1.7	231	111	0.0	3.1	11		290			
Nanafalia Formation															
Lower Wilcox Aquifer	20	1603	11-20-63	5.8	1.6	562	680	4.0	9.2	750	0.3	1740	3170	8.3	26
	21	271	7-20-61	7.2	2.9	78	17	2.2	0.0	6.4	0.0	112	126	7.2	
Cretaceous-Upper Ripley Formation	22	630	8-6-56	9.2	4.1	566	214	7.8	2.4	33	0.5	587	616	7.6	
	23	187	7-25-57	33	3.9	122	5.6	1.0	6.8	3.5	0.4	120	212	7.9	
Coffee Sands	24	670	7-25-57	5.7	1.3	288	106	4.8	4.8	2.5	1.2	284	454	8.5	
Eutaw Formation (unrestricted)	25	1034	12-2-54	27	11	150	85	5.2	6.0	130	0.1	358	716	7.7	20
	26	1070	6-13-69	46	9.6	213	24	3.4	15	13	0.3	231	400	8.0	20
Eutaw Formation (restricted)	27	1470	12-3-54	4.8	1.7	466	412	5.6	1.0	380	2.4	1070	1890	7.9	
	28	1613	6-11-60	6.4	1.7	300	133	10	0.0	120	1.7	482	900	8.4	
Tuscaloosa Group															
Gordo Formation	29	1807	10-17-56	4.6	0.7	496	281	5.1	4.4	158	1.9	821	1250	8.1	24
	30	1505	8-6-56	4.4	2.0	256	164	5.1	0.6	125	1.4	456	784	8.1	
Coker Formation	31	2406	3-22-67	23	2.6	196	300	3.7	0.4	418	0.0	861	1650	7.7	
	32	781	5-18-59	5.6	1.1	184	65	2.5	8.8	3.2	0.9	196	305	7.9	19

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

As indicated in table 48, several aquifers or portions of aquifers yield water exceeding the recommended limiting concentrations for drinking water. The maximum concentrations of these waters range in dissolved solids for 505 mg/l (Meridan Sand Member) to 2,700 mg/l (Cockfield Formation) and in chloride from 380 mg/l (Eutaw Formation - restricted) to 1170 mg/l (Cockfield Formation). Sulfate was not a limiting factor in any of the wells represented in table 48. Sodium bicarbonate water and sodium chloride water each account for approximately the same number of aquifers containing excessively mineralized water. Aquifers that can yield highly mineralized water include the Pleistocene Alluvium, the Sparta Sand, the Winona Sand, the Tallahatta Formation, the Meridian Sand Member, the Meridian-Upper Wilcox Aquifer, the Tuscahoma Formation, the Nanafalia Formation, the Upper Ripley Formation, the Eutaw Formation (restricted), and the Tuscaloosa Group.

Appendix C shows the altitude of the base of fresh water in the Coastal Plain aquifers of the region. In WRPA the base of fresh water is more than 1,000 feet below mean sea level over most of the planning area. In the Vicksburg area, the base of fresh water ranges from about 1,500 to more than 2,000 feet below sea level.

The recent U. S. Geological Survey study of ground water pollution (4) discussed two occurrences in WRPA 4. The pollutant is salt brine. Figure 2 shows the location of the reported areas of ground water pollution.

In Yazoo County, Mississippi, about 20 miles southwest of Yazoo City, salt-water springs have originated from improper disposal of oil-field wastes from Tinsley Field.

In Yalobusha County, Mississippi, several miles southeast of Scobey, an isolated well 1,120 feet deep yielded water with a chloride concentration of 465 mg/l in an area where chloride concentrations are low.

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

Municipal

WRPA 4 has 43 sewered communities of 1,000 or more inhabitants. The total population served in 1970 is estimated at 258,200, as shown in table 49. The total daily raw waste production is 46,480 pounds of BOD. According to Programs A and B, the sewered population is expected to be 483,400 and 549,100 by 2020, which are increases of 87 and 113 percent, respectively. Correspondingly, the total raw BOD waste production will increase to 96,680 pounds per day by 2020 for Program A and to 109,820 for Program B.

Table 49 - Municipal and Industrial Organic Waste Production, WRPA 4

Load Category	Daily Raw Organic Waste Production 1970	Program	1980	2000	2020
Municipal					
P.E. 1/	258,200	A	279,400	352,600	483,400
		B	304,000	398,700	549,100
#BOD 2/	46,480	A	53,090	70,520	96,680
		B	57,760	79,740	109,820
Industrial					
P.E.	517,600	A	588,400	968,900	1,909,800
		B	642,300	1,117,900	2,254,500
#BOD	93,160	A	111,790	193,780	381,960
		B	122,040	223,590	450,900
Total					
P.E.	775,800	A	867,800	1,321,500	2,393,200
		B	946,300	1,516,600	2,803,600
#BOD	139,640	A	164,880	264,300	478,640
		B	179,800	303,330	560,720

1/ P.E. - Population equivalents: See Methodology.
2/ #BOD - Pounds of 5-day biochemical oxygen demand.

Of the 43 sewered communities with 1,000 or more inhabitants, there are 30 (70 percent of the WRPA total) that have less than 5,000 inhabitants. The total sewered population of these smaller communities is 64,700 or 25 percent of the total for WRPA 4. The average raw waste production per community is 388 pounds of BOD_5 per day. Six communities (14 percent) are in the range of 5,000 to 9,900 inhabitants and have a total sewered population of 46,400 or 18 percent of the WRPA total. The average raw waste production per community is 1,392 pounds of BOD_5 per day. Seven communities (16 percent) are in the range of 10,000 to 49,900 inhabitants and comprise a sewered population of 147,100 or 57 percent of the total for WRPA 4. The average raw waste production per community is 3,783 pounds of BOD_5 per day.

Many of the sewered communities discharge their effluent to small streams that seasonally have little or no flow. As a consequence, even secondary treatment of sewage may be inadequate and local water quality problems may arise.

Industrial

In 1970 there were 84 industries classified as producing biodegradable wastes in WRPA 4. Major categories involved in this waste production were Food and Kindred Products (73 percent of the total number of industries in WRPA 4), Chemical and Allied Products (20 percent), Paper and Allied Products (4 percent), Petroleum and Coal Products (2 percent) and Rubber and Plastics Products (1 percent).

Industrial organic waste production is comparatively small in WRPA 4. The 84 industries inventoried are located in or near 27 communities with Vicksburg, Yazoo City and Greenville, Mississippi, being the largest centers. In 1970 the combined municipal (domestic and commercial) and industrial loads discharged to the Mississippi River from Vicksburg and Greenville were 30,779 and 4,102 pounds of BOD_5 per day, respectively. The load discharged to the Yazoo River from Yazoo City was 5,302 pounds of BOD_5 per day. Paper, food processing, chemicals, and rubber and plastics industries produce the largest quantities of organic wastes in the Vicksburg area. Paper, chemicals, and petroleum and coal industries produce organic wastes in the Yazoo area. In the Greenville area food processing and chemicals industries are the main industries that produce organic wastes.

As shown in table 49, the population equivalent for 1970 will increase from 517,600 to 1,909,800 and 2,254,500 by 2020 according to Programs A and B. These are increases of 269 and 336 percent, respectively. The corresponding raw BOD waste load before treatment of 93,160 pounds per day in 1970 are projected to be 381,960 pounds per day by 2020 for Program A and to 450,900 for Program B.

Agricultural

Among the seven categories of farm animals listed in table 46, cattle and calves is the largest in terms of waste production, accounting

for 78 percent of the daily total. Turkeys is the smallest category and totals 0.04 percent of the total waste production.

The total daily raw organic wastes produced by livestock and poultry in WRPA 4 in 1970, and estimated for the projected years, is indicated in table 50. As explained in the Regional Summary, agricultural animal wastes generally constitute non-point sources of pollution in the total waste production must, therefore, not be equated with BOD loads from municipal and industrial sources.

The total daily production of organic wastes from livestock and poultry in 1970 was 894,000 pounds of BOD_5. For Programs A and B this total is expected to increase to 1,968,000 and 2,113,600 pounds respectively by the year 2020.

The land area in WRPA 4 affected by erosion in 1970 totalled about 38 percent and ranged from 0.9 percent along Steele Bayou to 58 percent in the Tallahatchie River Basin. The average gross erosion of the affected areas was 7.4 tons per acre/year and ranged from 2.2 in the Steele Bayou Basin to 12.4 tons per acre/year in the Coldwater River Basin.

The use of fertilizers on extensive tracts of cultivated land is a significant potential source of nutrients that can be carried to the streams by runoff and wind. Little information is available on this loss of fertilizers; however, it would appear that 10 percent may be a realistic low estimate (18). In 1969 the use of fertilizers in WRPA 4 totalled 244,580 tons, which were applied to 1,616,569 acres. This averages 303 pounds of fertilizer per acre per year.

There are no compiled figures on the quantities of agricultural pesticides used in the Lower Mississippi Region. However, insecticides and herbicides are applied by aerial and land spraying or dusting. The loss of significant quantities of pesticides carried to streams by runoff from rainfall or blown by winds is to be expected, possibly on the same order of magnitude (at least 10 percent) as for the loss of fertilizers.

Table 50 - Organic Wastes From Livestock and Poultry, WRPA 4

	1970	Program	1980	2000	2020
BOD_5 1/	893,950	A	1,122,550	1,478,400	1,968,100
		B	1,122,550	1,588,000	2,113,600

1/ Pounds of 5-day biochemical oxygen demand per day.

Non-Organic Wastes

In WRPA 4 the non-BOD wastewater discharges from municipal, industrial and agricultural sources are not adequately quantified for discussion. However, present State and Federal discharge permit programs require water quality data which will define the quantities of the wastes that occur at these sources and that are subject to control.

Bacteria

The need for disinfection of sanitary wastes for the control of waterborne diseases, as discussed in the Regional Summary, is indicated in table 51 for WRPA 4.

Table 51 - Flows Containing Harmful Bacteria, WRPA 4

	1970	Program	1980	2000	2020
Flow 1/	40.3	A	49.6	67.5	92.8
		B	54.4	76.5	105.2

1/ Millions of gallons of effluent per day.

EXISTING TREATMENT

Municipal and industrial organic waste treatment levels vary widely between communities and between industries. Average municipal sewage treatment for communities located in WRPA 4 are estimated at 50 percent in the State of Mississippi. Total municipal BOD_5 removed by existing treatment in 1970 was 23,240 pounds per day.

Average industrial organic waste treatment is estimated at 55 percent BOD_5 removed throughout the entire region, including WRPA 4. Total industrial BOD_5 removed by existing treatment in 1970 was 51,240 pounds per day.

Agricultural organic wastes are for the most part dispersed over wide areas and generally do not exist as point source of pollution. Consequently, most wastes are subject to normal practices of land application generally beneficial to soils and crops, but subject to varying degrees of runoff from rainfall and snowmelt.

Disinfection of discharges for disease control are estimated at 30 percent in Mississippi. The total chlorinated discharge in 1970 was 12.1 mgd.

Oxidation ponds are one method of treating feedlot wastes.

WATER QUALITY CONTROL NEEDS

Water quality control needs exist wherever pollutants are discharged to water supplies. As stated under "Purpose," quantified needs herein are limited to organic or biodegradable wastes, and to bacteria. Organic pollutants are expressed in pounds of BOD_5 per day. Bacterial pollution is expressed in terms of flow in millions of gallons per day requiring treatment.

As explained in "Methodology" municipal and industrial waste loadings are considered point loadings to streams, whereas 95 percent of agricultural loadings are considered non-point sources of pollution. Projected net loadings to streams to the year 2020 are based on calculated total raw waste production minus the quantity of BOD removed or quantity of effluent disinfected by present (1970) treatment held as a constant through the projected 50-year period. Table 52 displays municipal and industrial organic pollution control needs. Table 53 displays point source agricultural BOD needs and table 54 shows needs for control of harmful bacteria.

The unsatisfied or net need shown in the 1970 column of the table indicates that significant pollution control problems exist in WRPA 4 at the present time. The more notable of these problem areas are displayed on figure 3.

Only five percent of the total agricultural BOD waste production is estimated as entering the surface waters as point spurce of pollution. The remaining organic wastes are disposed of by such methods as direct land application, recycling, aerated lagoon-irrigation systems, holding tanks, or some combination of these. Nonetheless, the wastes can cause an ultimate surface water problem unless proper land management practices are instituted and maintained.

Bacterial pollution is probably persistant in stream reaches receiving nondisinfected effluent from population centers. In WRPA 4 effluent disinfection (chlorination) is not practiced extensively and by 2020 the problem may increase more than twofold if present levels of disinfection are maintained.

Table 52 - Municipal and Industrial Organic Pollution Control Needs, WRPA 4

Load Category	1970	Program	1980	2000	2020
			(Pounds of BOD_5 per day)		
Municipal					
Total	46,480	A	53,090	70,520	96,680
Exstg. Trmt.	23,240		23,240	23,240	23,240
Net Need	23,240		29,850	47,280	73,440
		B	57,760	79,740	109,820
			23,240	23,240	23,240
			34,520	56,500	86,580
Industrial					
Total	93,160	A	111,790	193,780	381,960
Exstg. Trmt.	51,240		51,240	51,240	51,240
Net Need	41,920		60,550	142,540	330,720
		B	122,040	223,590	450,900
			51,240	51,240	51,240
			70,800	172,350	399,660
Total					
Total	139,640	A	164,880	264,300	478,640
Exstg. Trmt.	74,480		74,480	74,480	74,480
Net Need	65,160		90,400	189,820	404,160
		B	179,800	303,330	560,720
			74,480	74,480	74,480
			105,320	228,850	486,240

Table 53 - Agricultural Organic Point Source Loads, WRPA 4

	1970	Program	1980	2000	2020
Waste Load 1/	31,170	A	39,570	47,570	62,530
		B	39,570	51,110	66,650

1/ Pounds of 5-day biochemical oxygen demand per day.

Table 54 - Bacterial Pollution Control Needs, WRPA 4

	1970	Program	1980	2000	2020
Total Discharge 1/	40.3	A	49.6	67.4	92.8
Chlorinated	12.1		12.1	12.1	12.1
Net Need	28.2		37.5	55.3	80.7
		B	54.4	76.5	105.2
			12.1	12.1	12.1
			42.3	64.4	93.1

1/ All figures are millions of gallons of effluent per day.

W R P A 5

STUDY AREA DESCRIPTION

General

In 1970 the Ouachita planning area (WRPA 5) was third in population in the Lower Mississippi Region. According to 1960 economic statistics, WRPA 5 was third in manufacturing and fifth in agricultural employment. It was the region's fourth largest producer of organic wastes from domestic and commercial sources in 1970, comprising 43 sewered communities of 1,000 or more inhabitants with a total population of 385,100 people. The WRPA ranked first in total organic wastewater production from industrial sources with 152 industries classified as producing biodegradable wastes in 1970. These industries generated organic wastes equivalent to those produced in an urban center of approximately 4.6 million people. WRPA 5 was first in total organic waste production from livestock and poultry. In 1970 this source produced organic wastes equivalent to an urban center of about 5.9 million people.

Water Pollution problems in WRPA 5 include: (1) point source discharge of organic wastes that exceed the assimilative capacity of the receiving streams, (2) periodic discharges of high sodium chloride waters to several streams, (3) indeterminate levels of pollution from agricultural organic wastes, fertilizers and pesticides, (4) general bacteriological pollution from non-disinfected effluents, and (5) few instances of ground water pollution.

Population

WRPA 5 comprises 20,412 square miles in southcentral Arkansas and northcentral Louisiana. In 1970 a total of 822,000 people inhabited the planning area and by 2020 the population is expected to increase to 1,210,000 and 1,377,000 according the respective projections of Programs A and B (see figure 8).

Of the total 1970 population of 822,000, the urban population was 403,000, or 49 percent of the total. Table 55 lists the total and urban populations of WRPA 5 for 1970 and the corresponding projected population for 1980, 2000, and 2020 for programs A and B.

There are 19 communities of 5,000 or more inhabitants. These are listed alphabetically by State in table 56 (see figure 8). Pine Bluff, Arkansas, with 57,389 inhabitants, is the largest community. In addition, there are 43 communities whose combined population of 94,300 ranges from 1,000 to 5,000 per community.

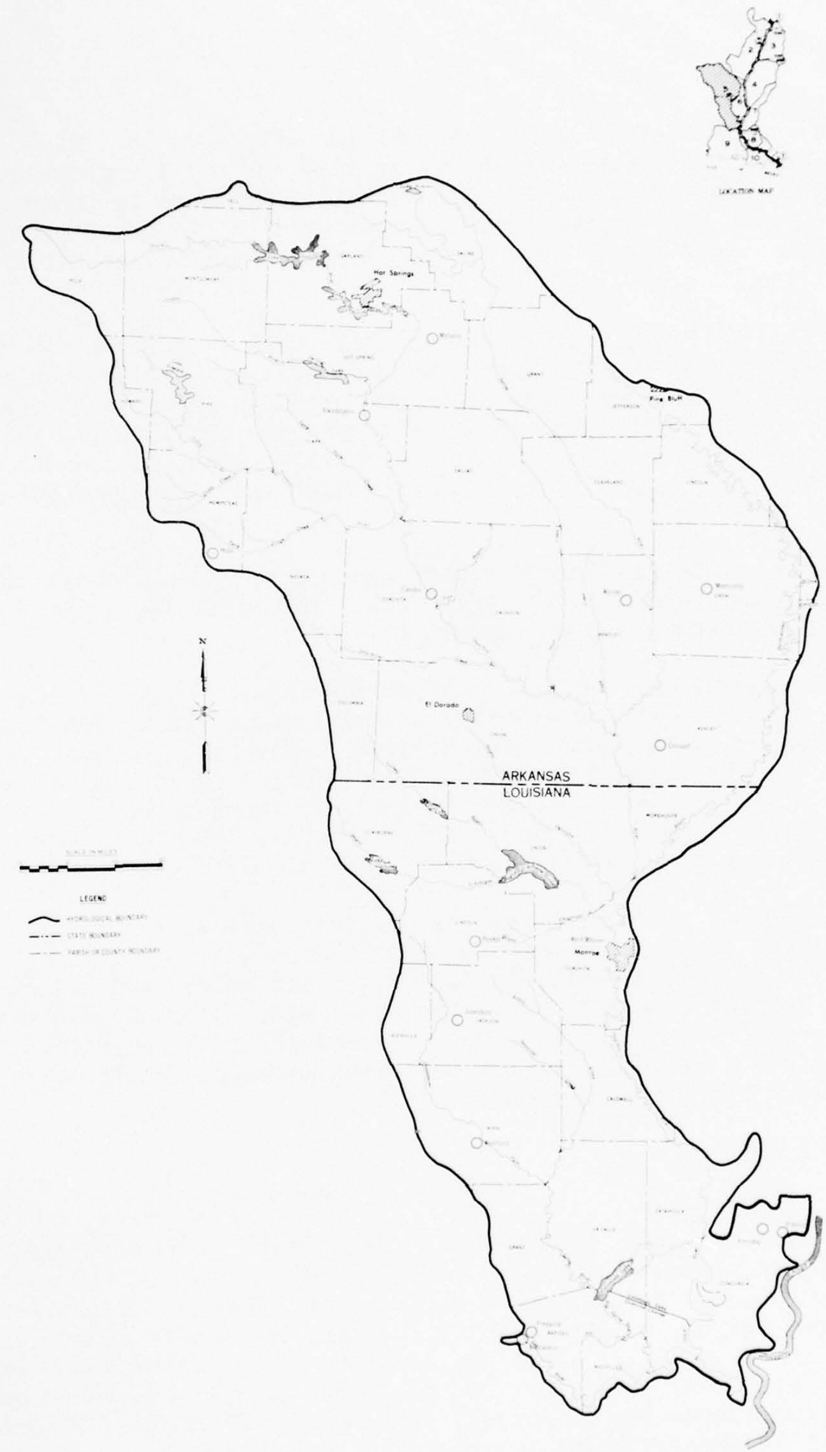
Table 55 - Population, WRPA 5

Base Population 1970	Programs	Projected Population 1980	2000	2020
Total Population				
	A	857,000	998,000	1,210,000
822,000	B	911,000	1,132,000	1,377,000
Urban Population				
	A	463,000	619,000	835,000
403,000	B	492,000	702,000	950,000

Table 56 - Principal Communities, WRPA 5

Community 1/	County or Parish	State	Community Population 1970
Crossett	Ashley	Arkansas	6,191
Warren	Bradley	"	6,433
Arkadelphia	Clark	"	9,841
Monticello	Drew	"	5,085
Hot Springs	Garland	"	35,631
Hope	Hemstead	"	8,810
Malvern	Hot Springs	"	8,739
Pine Bluff	Jefferson	"	57,389
Camden	Ouachita	"	15,147
El Dorado	Union	"	25,283
Vidalia	Concordia	Louisiana	5,538
Ferriday	Concordia	"	5,239
Jonesboro	Jackson	"	5,072
Ruston	Lincoln	"	17,365
Monroe	Ouachita	"	56,374
West Monroe	Ouachita	"	14,868
Alexandria	Rapides	"	41,557
Pineville	Rapides	"	8,951
Winnfield	Winn	"	7,142
Nineteen communities with a total population of:			340,655

1/ Incorporated places (cities, villages, towns, or boroughs) of 5,000 or more inhabitants.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WATER RESOURCE PLANNING
AREA 5

FIGURE 8

Economy

Total employment in WRPA 5 in 1968 was 272,706. This is an increase of 11.0 percent over 1960. By 2020 the total employment, according to Programs A and B projections, is expected to increase to 432,000 and 510,000 respectively. As compared to the other planning areas in the Lower Mississippi Region, WRPA 5 was third in total employment in 1968.

One hundred fifty two industries that yield wastewaters in relatively large quantities and high BOD concentrations are located in WRPA 5. Food, paper, chemicals and petroleum products industries comprise about 93 percent of the organic waste producing industries in the planning area. Among these four major industrial groups, food and kindred products and paper and allied products industries comprise about 47 and 18 percent respectively.

Table 57 indicates the growth of employment and of industrial water use for Program A and B to the year 2020. The water use indexes are an average of the employment and earnings.

Mining operations include metallic minerals, fuels, and nonmetallic minerals. Vanadium is the principal metal mined. Production figures for vanadium are withheld (confidential information). Natural gas and petroleum are the major fuels mined. In 1969 the production of natural gas was 144,180 million cubic feet and 43,405 thousand barrels of petroleum were mined. Among the nonmetallic minerals, sand and gravel rank first in production at 6,617,000 short tons mined in 1969.

Agricultural production reports of livestock and poultry place cattle and calves and hogs and pigs among the most numerous of large farm animals. In 1970 there were 584,000 cattle and calves and 149,300 hogs and pigs, ranking WRPA 5 third in the Lower Mississippi Region with respect to production of cattle and calves and fifth in production of hogs and pigs. Table 58 indicates the projected increase in production to the year 2020 for Programs A and B.

Selected Streams

The Ouachita River, Saline River, Red River, Bayou Bartholomew, Bayou DeLoutre, Bayou D'Arbonne, and Little River receive the largest organic waste loads discharged in WRPA 5. The flow of these streams is sustained largely by ground-water seepage, by surface runoff from rainfall, and to a minor extent by snowmelt. Their waste assimilative capacities are least during periods of lowest streamflow, which generally occur in the months of August, September, and October, with August and October frequently being the most critical months.

Table 57 - Employment, WRPA 5

Program	Year	Major Industry Employment	Major Industry Earnings 1/	Indexes Employment	Indexes Earnings	Indexes Water Use
A	1968	272,700	1,390	100	100	100
	1980	283,000	2,064	104	148	126
	2000	343,000	4,506	126	324	225
	2020	432,000	9,976	158	719	439
B	1968	272,700	1,390	100	100	100
	1980	310,000	2,263	114	163	139
	2000	396,000	5,212	145	375	260
	2020	510,000	11,766	187	846	517

1/ In millions of dollars. Industrial water use indexes are an average of employment and earnings indexes.

Table 58 - Numbers of Livestock and Poultry, WRPA 5

Livestock and Poultry	1970	Program	1980	2000	2020
Cattle and Calves	584,000	A	743,700	1,001,100	1,344,500
		B	743,700	1,075,500	1,443,800
Milk Cows	31,400	A	28,800	35,500	43,400
		B	28,800	38,100	46,500
Hogs and Pigs	149,300	A	170,400	222,600	289,000
		B	170,400	239,100	310,300
Sheep and Lambs	12,300	A	9,400	11,100	13,700
		B	9,400	11,900	14,700
Chickens	1,456,600	A	1,600,200	2,048,400	2,594,800
		B	1,600,200	2,200,500	2,786,500
Broilers	59,981,800	A	83,656,600	116,808,600	156,822,400
		B	83,656,600	125,480,400	168,408,500
Turkeys	3,700	A	4,900	6,900	9,400
		B	4,900	7,500	10,100

Appendix C contains a streamflow summary for selected sites in WRPA 5. Streamflow characteristics are affected by flow regulation and withdrawals for water supply. The recorded flows range from a maximum momentary flow of 183,000 cfs on the Ouachita River at Camden, Arkansas, to minimum momentary flows of 0 cfs at 16 of the 32 stream gaging stations. Zero flow is assumed to occur on numerous small streams throughout the planning area. Minimum annual flows range from 5,882 cfs on the Ouachita River at Monroe, Louisiana, to 0 cfs on Garrett Creek at Jonesboro, Louisiana.

Major water withdrawals are for hydroelectric power plants, for fish and wildlife enhancement and for irrigation. The headwaters of the Ouachita River has three reservoirs for power generation: Lake Ouachita, Lake Hamilton and Lake Catherine. Lake Ouachita is a multipurpose reservoir and is used also for flood control and recreation. Further information on reservoirs and flow regulation is available from Appendix C.

Major Aquifers

Ground water supplies in WRPA 5 are obtained from aquifers that comprise rock units of Quaternary, Tertiary, Cretaceous, and Pennsylvanian ages. Aquifers that yield major quantities of water for municipal, industrial, and agricultural use are the Quaternary Alluvium and the Sparta Sand of the Eocene Series.

The water quality of these aquifers is discussed in the next section of this appendix. A listing of aquifers in WRPA 5 is presented as part of table 60 of that section. For details regarding the geology of the aquifers, see Appendix C.

PRESENT STATUS

Water Use

Water use for municipal supply, industry and irrigation totalled 626.4 mgd in 1970. Municipal supply accounted for 54.3 mgd (8.7 percent), industrial use for 206.7 mgd (33.0 percent) and irrigation for 365.4 mgd (58.3 percent) of this total. As compared to the other planning areas, WRPA 5 was fifth in total water use. By 2020 it is expected that water use for Programs A and B will increase by 146 percent and 180 percent, respectively, for municipal supply, by 625 and 773 percent for industry and 52 and 70 percent for irrigation.

Cooling water used for thermal electric power generation totalled 1071.0 mgd in 1970, and thus constituted the largest water demand in WRPA 5. As compared to the other planning areas WRPA 5 ranked third in total thermal electric cooling water requirements. By 2020 it is expected that this water use will increase 221 percent for Programs A and 266 percent for Program B.

Water Quality

Surface Water

In WRPA 5 water analyses are available on the Ouachita River, Smackover Creek, Saline River, Bayou Barthelomew, Bayou DeLoutre, Bayou D'Arbonne, Little River, and the Red River. Selected analyses of water sampled under relatively high and low streamflow are listed for these major streams in table 59.

The analyses listed in this table indicate that the rivers in WRPA 5 are calcium bicarbonate and sodium chloride type waters with maximum recorded concentrations of 3,730 mg/l calcium, 220 mg/l bicarbonate, 21,000 mg/l sodium, and 41,400 mg/l chloride and 73,000 mg/l dissolved solids. Streams that have had periods of high chloride and dissolved solids concentrations include Smackover Creek near Norphlet, Arkansas, the Ouachita River at and downstream from Calion, Arkansas, Bayou DeLoutre below the Arkansas-Louisiana border, Bayou D'Arbonne near Dubach, Louisiana, Little River near and downstream from Rochelle, Louisiana, and the Red River near Hosston (which is outside the study area in the northwest corner of Louisiana) and at Alexandria, Louisiana. As indicated in table 127, the recommended limiting concentrations of dissolved solids, sulfates, and chlorides for drinking water are 500, 250, and 250 mg/l, respectively.

Ground Water

In WRPA 5 analyses of ground water are available from aquifers of Quaternary, Tertiary, Cretaceous, Pennsylvanian, Mississippian, Devonian, and Ordovician ages. The analyses listed in table 60 represent ranges in chemical composition of well water from each aquifer as based on maximum and minimum concentrations of dissolved solids, sulfate, and chloride.

Table 59 - Stream Quality, WRPA 5 1/

Stream Sampling Station	Date Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/1)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/1)	Temp. °C
Ouachita River at Monroe, Louisiana	10-16/18-54 5-21/31-58	3,870 90,600	158 0.0	40 0.0	5 12	-----884----- 12		18 3.8	1,730 7.2	23 0.9	2,860 35	5,350 54	5.7 6.8		22
Bayou DeLoutre on Dirt Road Just South of Arkansas	10-25-56 11-22-56		394 166	92 34	208 60	2,720 941	30	70 50	5,000 1,740		8,420 2,970	14,300 5,310	7.3 6.9		
Bayou DeLoutre near Laran, Louisiana	6-21-58 5-20-58	27 1,150	128 5.0	19 0.4	38 7	610 18	9.8	18 1.0	1,200 31	0.3 0.6	2,300 66	3,740 135	6.4 5.6		
Bayou DeLoutre at DeLoutre, Louisiana	6-4-68		12	2.2	20	42	0.4	5.2	79	0.2	193	313			23
Bayou DeLoutre near Sterlington, Louisiana	6-4-68		91	1.8	16	24	0.5	5.2	47	0.2	138	206			
Bayou D'Arbonne at Homer, Louisiana	11-26-63 2-27-64		2.5 2.3	0.9 1.0	6 6	4.1 2.5	1.3 0.8	5.4 3.4	7.0 5.0	0.5 0.2	80 35	51 42	6.0 6.8		
Bayou D'Arbonne near Dubach, Louisiana	11-18-53 5-14-54	0.04 3,400	170 3.1	23 1.3	50 8	--669---- 7.9		90 5.0	1,350 13	0.5 0.5	2,370 46	4,370 72.9	6.8 5.8		
Bayou D'Arbonne near Farmersville, Louisiana	6-29-60 12-21-59		23 5.6	3.1 1.2	12 6	66 15	4.0 2.7	7.8 9.0	143 28	0.0 0.8	330 78	519 129	5.6 5.9		
Bayou D'Arbonne near Monroe, Louisiana	6-4-48		7.0	1.1	14	14	1.0	4.2	27	0.1	66	127			23
Little River near Rochelle, Louisiana	11-2-65 4-18-68	22 9,420	169 4.3	98 0.8	160 18	6,450 5.9	31 0.6	24 5.6	10,300 6.5	0.1	18,300 58	30,000 61	6.6 6.5		20
Little River near Pollock, Louisiana	8-25-64 3-25-64		115 7.3	78 4.8	81 32	4,510 120	22 4.7	56 16	7,350 180	0.8	12,600 37	20,100 646	6.9 6.9		
Red River near Hosston, Louisiana	8-15/20-64 4-26/30-64	3,940 73,100	130 24	17 4.1	129 81	228 11	5.5 2.2	258 13	388 14	0.7 0.4	1,190 117	1,850 197	7.9 7.0		29 2/ 21 2/
Red River at Alexandria, Louisiana	10-11/20-56 7-1/9-53	1,660 96,570	123 17	38 3.6	220 62	----227---- 8.2		250 6.6	365 12	1.2 1.2	1,130 91	1,930 156	8.3 7.9		22-26 27 2/

Table 59 - Stream Quality, WRPA 5 (Cont'd) 1/

Stream Sampling Station	Date Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/l)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/l)	Temp. °C
Ouachita River near Mount Ida, Arkansas	8-1/10-52 1-11/20-50	33.9 5,632	14 2.6	2.2 0.9	49 11	2.6 3.3	1.0	3.6 3.0	3.0 2.5	0.8 1.4	66 19	92.7 35.9	7.9 7.1		24 2/ 10-14
Ouachita River at Blakley Mountain Dam near Hot Springs, Arkansas	1-26-54 7-27-54	5 488			64 99	4.0 2.0	2.2 3.0			1.0 1.0		133 82	7.8 7.1		
Ouachita River near Malvern, Arkansas	8-29/31-50 1-11/19-50	373 21,900	10 3.4	6.2 1.2	3 15	----2.5---- 3.1		48 3.1	2.0 2.0	0.9 1.0	88 21	140 40.3	5.5 7.5		
Ouachita River at Arkadelphia, Arkansas	5-9/10-63 12-17/23-59	813 13,000	10 4.3	2.2 1.5	31 14	93 1.8	1.5 1.2	9.6 6.8	140 2.5	6.7 1.3	283 26	559 46	7.6 6.6		27 2/ 8-14
Ouachita River at Camden, Arkansas	11-22/24-49 2-11/13,16-50	4,577 44,120	9.6 4.8	3.0 1.2	24 15	45 4.9	6.7	13 3.0	79 5.5	0.8 2.8	193 30	325 59.0	7.7 7.0		10-18
Smackover Cr. near Norphlet, Arkansas	9-1/4-54 2-13/17-65		3,730 6.0	955 3.0	52 5	21,100 30	268 1.8	1.0 5.2	41,400 63	0.7	73,000 144	92,000 236	6.7 6.6		33-37 9 2/
Ouachita River at Calion, Arkansas	8-6-54 12-7/10-52		429 6.8	110 3.1	0 21	2,300 5.2	36	40 5.1	4,660 12	5.0 1.6	9,310 61	13,600 78	4.38 7.0		33 12 2/
Saline River near Benton, Arkansas	11-1/10-50 3-12/14-50	125	20 5.9	5.6 1.9	82 24	2.6 2.2	1.7	6.3 5.3	4.2 1.0	1.4 1.0	96 29	142 53.9	8.0 7.2		10-19 8
Saline River near Tull, Arkansas	7-20-64 4-16-64		17 13	4.0 3.2	67 48	5.2 2.3	1.4 0.7	12 9.2	5.0 3.5	0.2 0.3	82 63	148 107	7.3 7.3		
Saline River near Leola, Arkansas	6-21-67	120	12	3.3	54	3.6	1.0			0.1	70	111	7.5		
Saline River near Rye, Arkansas	7-13/15-55 1-11/14-50	183 20,960	21 2.2	4.4 1.2	51 7	30 2.1		85 5.0	4.5 3.0	0.4 1.4	186 18	280 37.1	7.5 7.1		27 2/ 9-14
Ouachita River near Crossett, Arkansas	11-1/3-47 2-11/18-49		151 10	47 1.8	18 8	811 5.4	8.3 0.9	9.9 5.7	1,640 22	6.0 1.8	2,700 79	5,090 104	6.5 7.0		7-10
Ouachita River at Felsenthal, Arkansas	1-27-57 3-1/9-50		4.7	0.8	2 12	6.4	0.3	13 4.0	1,360 10	5.5 6.5	2,730 44	4,390 68.7	5.1 6.5		9 12 2/
Bayou Bartholomew near McGee, Arkansas	10-3-61 3-1/2-61	138 4,070	2.2	2.4	123 18	43 2.3	2.5	33 5.4	55 2.0	4.1 1.9	270 28	454 51	8.4 7.0		19 13 2/
Bayou Bartholomew near Wilmot, Arkansas	11-21/26-52 5-11/31-53		31 4.0	8.7 1.4	158 21	20 2.0	3.2 2.7	5.8 2.2	18 2.5	1.0 1.5	197 32	306 47	8.0 6.9		
Bayou Bartholomew near Jones, La.	12-5-67 11-21-57	43 4,510	32 2.1	9.7 1.4	161 14	24 1.8	2.8 3.8	4.8 2.8	24 2.0	0.2 0.5	191 29	347 43	7.7 6.6		11
Bayou Bartholomew near Beekman, Louisiana	11-20-52 5-12-53	141 6,080	28 3.0	8.6 1.2	145 16	----19---- 1.6	1.8	7.0 2.0	15 0.8	0 1.0	169 26	286 42.2	7.3 6.1		

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

2/ Average daily temperature.

Table 60 - Ground-Water Quality, WRPA 5

Aquifer System[1/]	Well No.	Well Depth (ft.)	Date of Collection	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH	Temperature (°C)
Quaternary															
Alluvium	1	158	7-22-68	94	24	536	243	5.4	6.2	298	6.0	973	1750	7.4	
	2	110	1-20-47	11	6.2	59	13	1.2	5.1	20	1.0	147	178	6.5	
Terrace Deposits	3	45	4-27-56	93	39	171	119	35	46	295	100	950	1510	6.9	18
	4	100	1-8-68	3.0	0.4	25	7.5	0.6	0.2	3.8	0.1	67	58	5.7	19
Tertiary Miocene	5	332	7-31-68	4.7	1.0	521	265	1.7	1.0	111	0.0	688	1160	8.1	
	6	310	7-23-68	4.0	1.5	168	61	0.8	3.8	6.5	0.1	181	285	7.9	
Eocene Series															
Jackson Group Undifferentiated	7	43	1-4-55	341	206	0.0	165	12	2210	46	1.7	3370	3240	3.6	20
	8	14	4-26-56	4.1	2.1	10	15	6.6	24	17	1.4	104	146	5.5	1(
Claiborne Group Cockfield Formation	9	510	12-12-68	3.6	0.7	716	397	2.0	0.8	180	0.2	970	1650	8.4	22
	10	170	8-5-64	1.4	0.5	12	1.7	1.9		2.5	0.2	44	27	6.3	19
Sparta Sand	11	581	5-17-68	1.3	0.7	356	360	1.9	0.0	367	0.0	918	1760	7.9	
	12	170	6-27-63	8.8	2.3	40	1.7	4.4	5.2	2.4		67	83	7.2	19
Cane River Formation	13	528	1-16-59	65	18	256	871	16	31	1360	1.9	2660	4360	8.2	21
	14	153	6-17-64	1.9	0.5	1.0	1.2	0.8	8.4	2.5		37	41	4.7	18
Carrizo Sand	15	954	4-9-59	20	7	518	1050	11	6	1350	0.8	2820	4680	8.4	18
	16	332	4-8-59	7.2	1.7	58	18	0.6	0.4	8.8	4.7	127	90	7.2	18
Wilcox Group, Undifferentiated	17	450	1-16-59	48	11	400	464	13	1.6	612	1.3	1440	2490	8.2	19
	18	161	5-3-63	8.1	3.1	71	13	2.5	0.4	4.4	0.1	132	125	7.1	19
Paleocene Series Midway Group, Undifferentiated	19	596	4-8-59	13	3.1	320	842	8.4	6.2	1120	1.5	2260	3970	8.0	18
Clayton Formation	20	115	5-11-64	2.1	1.6	7.0	10	0.2	0.0	12	5	70	86	5.5	18
Cretaceous Pike Gravel	21	103	6-17-59	54	12	140	23	3.3	92	16	0.6	456	325	6.9	18
Pennsylvania Series Stanley Shale	22	110	6-25-64	51	11	189	26	0.8	7.8	47		278	473	7.7	18
	23	93	6-26-64	1.4	8.2	42	2.2	0.7	4.8	2.7		65	87	6.3	18
Mississippian Series Jackfork Sandstone	24	85	10-24-62	15	11	158	30	1.5	3.4	12	2.1	169	290	8.1	19
	25	121	5-5-63	7.6	3.7		8.5	2.8			0.2	104	114	8.0	20
Devonian Series Arkansas Novaculite	26	110	8-9-62	20	4.8	112	15	3.6	12	2.5	0.2	146	114	8.0	22
Ordovician Series Polk Creek Shale	27	49	10-22-62	8.2	2.5	39	1.6	0.9	6.4	2.0	0.4	43	76	7.0	21
Womble Shale	28	124	8-9-62	62	11	302	48	1.5	24	22	0.6	337	568	7.7	19
	29	75	8-9-62	13	11	54	8.9	0.7	45	6	0.2	150	217	7.5	17

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

Most aquifers that yield water meeting the recommended limiting concentrations for drinking purposes yield calcium bicarbonate water. Exceptions to this are parts of Quaternary and Claiborne Group, Cockfield Formation, which yield bicarbonate waters with approximately equal concentrations of calcium and sodium.

As indicated in table 60, several aquifers or portions of aquifers yield water exceeding the recommended limiting concentrations for drinking water. The maximum concentration of these waters range in dissolved solids from 688 mg/l (Miocene) to 3,370 mg/l (Jackson Group), in sulfate (only in a single sample) a concentration of 2,210 mg/l and in chloride from 295 mg/l (Terrace Deposits) to 1,360 mg/l (Cane River Formation). Sodium chloride water is the most common type among these aquifers containing excessively mineralized waters. However, sodium bicarbonate water and calcium bicarbonate water are present in several aquifers. Aquifers that can yield highly mineralized water include the Quaternary Alluvium, Quaternary Terrace Deposits, Jackson Group, Sparta Sand, Cane River Formation, Carrizo Sand, Wilcox Group, and Midway Group.

The recent U. S. Geological Survey study of ground water pollution (4) discusses two such occurrences in WRPA 5. The pollutants are salt brines.

In LaSalle Parish, Louisiana, near Nebo, salt-water disposal pits have caused fresh water wells to become salty.

In Catahoula Parish, Louisiana, a wildcat well flows 1,000 gpm of salty water.

In Concordia Parish salt water was accidentally injected into a shallow aquifer. Figure 2 shows the location of the reported areas of ground-water pollution.

Appendix C shows the altitude of the base of fresh water in the Coastal Plain aquifers of the region. In WRPA 5 the base of fresh water ranges from less than 1,500 feet below sea level in Jefferson County, Arkansas, to above mean sea level in Grant, LaSalle, and Catahoula Parishes, Louisiana.

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

Municipal

WRPA 5 has 43 sewered communities of 1,000 or more inhabitants. The total population served in 1970 is estimated at 385,000, as shown in table 61. The total daily raw waste production is 69,320 pounds of BOD. According to Programs A and B, the sewered population is expected to be 732,900 and 833,900 by 2020, which are increases of 90 and 117 percent, respectively. Correspondingly, the total raw BOD waste production will increase to 146,580 pounds per day by 2020 for Program A and to 166,780 for Program B.

Of the sewered communities with 1,000 or more inhabitants, there are 27 (63 percent of the WRPA total) that have less than 5,000 inhabitants. The total sewered population of these smaller communities is 60,300 or 16 percent of the total for WRPA 5. The average raw waste production per community is 400 pounds of BOD_5 per day. Eight communities (19 percent) are in the range of 5,000 to 9,900 inhabitants and have a total sewered population of 61,100 or 16 percent of the WRPA total. The average raw waste production per community is 1375 pounds of BOD_5 per day. Six communities (14 percent) are in the range of 10,000 to 49,900 inhabitants and comprise a sewered population of 149,900 or 39 percent of the total WRPA 5. The average raw waste production per community is 4,497 pounds of BOD_5 per day. Two communities (5 percent) have more than 50,000 inhabitants and comprise a total sewered population of 113,800 or 30 percent of the WRPA total. The average raw waste production per community is 10,200 pounds of BOD_5 per day.

Many of the sewered communities discharge their effluent to small streams that seasonally have little or no flow. As a consequence, even secondary treatment of sewage may be inadequate and local water quality problems may arise.

Industrial

In 1970 there were 152 industries classified as producing biodegradable wastes in WRPA 5. Major categories involved in this waste production were Food and Kindred Products (73 percent of the total number of industries in WRPA 5), Chemical and Allied Products (20 percent), Paper and Allied Products (4 percent), Petroleum and Coal Products (2 percent) and Rubber and Plastics Products (1 percent).

Industrial waste production is fairly large in WRPA 5. The 152 industries inventoried are located in or near 26 communities, with Pine Bluff, Arkansas and Monroe, Louisiana being two of the largest centers. In 1970 the combined municipal (domestic and commercial) and industrial loads discharged to the Arkansas River from Pine Bluff, and to the Ouachita River from Monroe were 76,744 and 73,156 pounds of BOD_5 per day, respectively. In the Pine Bluff area the largest quantities

Table 61 - Municipal and Industrial Organic Waste Production, WRPA 5

Load Category	Daily Raw Organic Waste Production				
	1970	Program	1980	2000	2020
Municipal					
P. E. 1/	385,100	A	419,000	539,400	732,900
		B	444,700	612,200	833,900
#BOD 2/	69,320	A	79,610	107,880	146,580
		B	84,500	122,440	166,780
Industrial					
P. E.	4,609,900	A	5,502,800	9,335,100	18,213,800
		B	6,070,500	10,787,200	21,450,000
#BOD	829,790	A	1,045,530	1,867,010	3,642,760
		B	1,153,410	2,157,450	4,289,990
Total					
P. E.	4,995,000	A	5,921,800	9,874,500	18,946,700
		B	6,515,200	11,399,400	22,283,900
#BOD	899,110	A	1,125,140	1,974,890	3,789,340
		B	1,237,910	2,279,890	4,456,770

1/ P. E. - Population equivalent: See Methodology.
2/ #BOD - Pounds of 5-day biochemical oxygen demand.

of organic wastes are produced by paper and allied products companies, while in the Monroe area the largest quantities of organic wastes are produced by chemical and allied products companies.

As shown in table 61, the population equivalent for 1970 will increase from 4,609,900 to 18,213,800 and 21,450,000 by 2020 according to Programs A and B. These are increases of 295 and 365 percent respectively. The corresponding raw BOD waste load before treatment of 829,790 pounds per day in 1970 is projected to be 3,642,760 pounds per day by 2020 for Program A and 4,289,990 pounds per day for Program B.

Agricultural

Among the seven categories of farm animals listed in table 58, cattle and calves is the largest in terms of waste production, accounting for 55 percent of the daily total. Turkeys is the smallest category and totals only 0.02 percent of the total waste production.

The total daily raw organic wastes produced by livestock and poultry in WRPA 5 in 1970, and estimated for the projected years, is indicated in table 62. As explained in the Regional Summary, agricultural animal wastes generally constitute non-point sources of pollution and the total waste production must, therefore, not be equated with BOD loads from municipal and industrial sources.

The total daily production of organic wastes from livestock and poultry in 1970 was 1,060,300 pounds of BOD_5. For Programs A and B this total is expected to increase to 2,480,600 and 2,663,900 pounds by the year 2020.

The land area in WRPA 5 affected by erosion in 1970 totalled about 50 percent and ranged from 3 percent along the Black River to 68 percent on Caston Bayou. The average gross erosion of the affected areas was 1.7 tons per acre/year and ranged from 0.2 in the Black River to 5.1 tons per acre/year in Bayou Bartholomew.

The use of fertilizers on extensive tracts of cultivated land is a significant potential source of nutrients that can be carried to the streams by runoff and wind. Little information is available on this loss of fertilizers; however, it would appear that 10 percent may be a realistic low estimate (18). In 1969 the use of fertilizers in WRPA 5 totalled 89,175 tons, which were applied to 595,499 acres. This averages 300 pounds of fertilizer per acre per year.

There are no figures on the quantities of agricultural pesticides used in the Lower Mississippi Region. However, insecticides and herbicides would be used and applied by aerial and land spraying or dusting. The loss of significant quantities of pesticides carried to streams by runoff from rainfall or blown by winds is to be expected, possibly on the same order of magnitude (at least 10 percent) as the loss of fertilizers.

Table 62 - Organic Wastes from Livestock and Poultry, WRPA 5

	1970	Program	1980	2000	2020
BOD_5 1/	1,060,300	A	1,367,000	1,856,400	2,480,600
		B	1,367,000	1,994,300	2,663,900

1/ Pounds of 5-day biochemical oxygen demand per day.

Non-Organic Wastes

In WRPA 5 the non-BOD wastewater discharges from municipal, industrial and agricultural sources are not adequately quantified for discussion. However, present State and Federal discharge permit programs require water quality data which will define the quantities of the wastes that occur at these sources and that are subject to control.

Bacteria

The need for disinfection of sanitary wastes for the control of waterborne diseases, as discussed in the Regional Summary, is indicated in table 63 for WRPA 5.

Table 63 - Flows Containing Harmful Bacteria, WRPA 5

	1970	Program	1980	2000	2020
Flow 1/	36.0	A	43.8	58.1	83.0
		B	46.4	65.9	94.4

1/ Millions of gallons of effluent per day.

EXISTING TREATMENT

Municipal and industrial organic waste treatment levels vary widely between communities and between industries. Average municipal sewage treatment for communities located in WRPA 5 are estimated at 80 percent in Arkansas and 50 percent in Louisiana. Total municipal BOD_5 removed by existing treatment in 1970 was 46,030 pounds per day.

Average industrial organic waste treatment is estimated at 55 percent BOD_5 removal throughout the entire region, including WRPA 5. Total industrial BOD_5 removed by existing treatment in 1970 was 456,380 pounds per day.

Agricultural organic wastes are for the most part dispersed over wide areas and generally do not exist as point sources of pollution. Consequently, most wastes are subject to normal practices of land application generally beneficial to soils and crops, but subject to varying degrees of runoff from rainfall and snowmelt.

Disinfection of discharges for disease control are estimated at 10 percent in Arkansas and 75 percent in Louisiana. The total chlorinated discharge in 1970 was 19.0 mgd.

WATER QUALITY CONTROL NEEDS

Water quality control needs exist wherever pollutants are discharged to water supplies. As stated under "Purpose," quantified needs herein are limited to organic or biodegradable wastes, and to bacteria. Organic pollutants are expressed in pounds of BOD_5 per day. Bacterial pollution is expressed in terms of flow in millions of gallons per day requiring treatment.

As explained in "Methodology" municipal and industrial waste loadings are considered point loadings to streams, whereas 95 percent of agricultural loadings are considered non-point sources of pollution. Projected net loadings to streams to the year 2020 are based on calculated total raw waste production minus the quantity of BOD removed or quantity of effluent disinfected by present (1970) treatment held as a constant through the projected 50-year period. Table 64 displays municipal and industrial organic pollution control needs. Table 65 displays pollution control needs for estimated agricultural point sources, and table 66 shows needs for control of harmful bacteria.

The unsatisfied or net need shown in the 1970 column of the tables indicates that significant pollution control problems exist in WRPA 5 at the present time. The more notable of these problem areas are displayed on figure 3.

Only five percent of the total agricultural BOD waste production is estimated as entering the surface waters as point sources of pollution. The remaining organic wastes are disposed of by such methods as direct land application, recycling, aerated lagoon-irrigation systems, holding tanks, or some combination of these. Nonetheless, the wastes can cause an ultimate surface water problem unless proper land management practices are instituted and maintained.

Bacterial pollution is probably persistant in stream reaches receiving nondisinfected effluent from population centers. In WRPA 5 the total nondisinfected discharge may increase by 2020 more than fourfold if present levels of disinfection are maintained.

Table 64 - Municipal and Industrial Organic Pollution Control Needs, WRPA 5

Load Category	1970	Program	1980	2000	2020
			(Pounds of BOD5)		
Municipal					
Total	69,320	A	79,610	107,880	146,580
Exstg. Trmt.	46,030		46,030	46,030	46,030
Net Need	23,290		33,580	61,850	100,550
		B	84,500	122,440	166,780
			46,030	46,030	46,030
			38,470	76,410	120,750
Industrial					
Total	829,790	A	1,045,530	1,867,010	3,642,760
Exstg. Trmt.	456,380		456,380	456,380	456,380
Net Need	373,410		589,150	1,410,630	3,186,380
		B	1,153,410	2,157,450	4,289,990
			456,380	456,380	456,380
			697,030	1,701,070	3,833,610
Total					
Total	899,110	A	1,125,140	1,974,890	3,789,340
Exstg. Trmt.	502,410		502,410	502,410	502,410
Net Need	396,700		622,730	1,472,480	3,286,930
		B	1,237,910	2,279,890	4,456,770
			502,410	502,410	502,410
			735,500	1,777,480	3,954,360

Table 65 - Agricultural Organic Point Source Loads, WRPA 5

	1970	Program	1980	2000	2020
Waste Loads 1/	51,090	A	65,710	89,540	118,870
		B	65,710	96,190	127,650

1/ Pounds of 5-day biochemical oxygen demand per day.

Table 66 - Bacterial Pollution Control Needs, WRPA 5

	1970	Program	1980	2000	2020
Total Discharge 1/	36.0	A	43.8	58.1	83.0
Chlorinated	19.0		19.0	19.0	19.0
Net Need	17.0		24.8	39.1	64.0
		B	46.4	65.9	94.4
			19.0	19.0	19.0
			27.4	46.9	75.4

1/ All figures are millions of gallons of effluent per day.

W R P A 6

STUDY AREA DESCRIPTION

General

In 1970 the Boeuf-Tensas planning area (WRPA 6) was eighth in population in the Lower Mississippi Region. According to 1960 economic statistics, WRPA 6 was ninth in manufacturing and sixth in agricultural employment. It was the region's eighth largest producer of organic wastes from domestic and commercial sources in 1970, comprising 18 sewered communities of 1,000 or more inhabitants with a total population of 80,200 people. The WRPA ranked seventh in total organic wastewater production from industrial sources with 12 industries classified as producing biodegradable wastes in 1970. These industries generated organic wastes equivalent to those produced in an urban center of approximately 0.2 million people. WRPA 6 was eighth in total organic waste production from livestock and poultry. In 1970 this source produced organic wastes equivalent to an urban center of about 2.1 million people.

Water pollution problems in WRPA 6 include: (1) point source discharges of organic wastes that exceed the assimilative capacity of the receiving streams, (2) indeterminate levels of pollution from agricultural organic wastes, fertilizers and pesticides, (3) local bacteriological pollution from nondisinfected effluents, and (4) a few instances of ground-water pollution.

Population

WRPA 6 comprises 5,520 square miles in eastern Louisiana and in extreme southeastern Arkansas. In 1970 a total of 188,000 people inhabited the planning area and by 2020 the population is expected to increase to 193,000 and 212,000 according to the respective projections of Programs A and B (see figure 9).

Of the total 1970 population of 188,000, the urban population was 73,000, or 39 percent of the total. Table 67 lists the total and urban populations of WRPA 6 for 1970 and the corresponding projected population for 1980, 2000, and 2020 for programs A and B.

There are four communities of 5,000 or more inhabitants. These are listed alphabetically by state in table 68 (see figure 9). Bastrop, Louisiana, with 14,713 inhabitants, is the largest community. In addition, there are 14 communities with populations ranging from 1,000 to less than 5,000, which total 37,600 people.

Table 67 - Population, WRPA 6

Base Population 1970	Programs	Projected Population 1980	2000	2020
Total Population				
	A	179,000	179,000	193,000
188,000	B	191,000	188,000	212,000
Urban Population				
73,000	A	75,000	86,000	102,000
	B	80,000	90,000	112,000

Table 68 - Principal Communities, WRPA 6

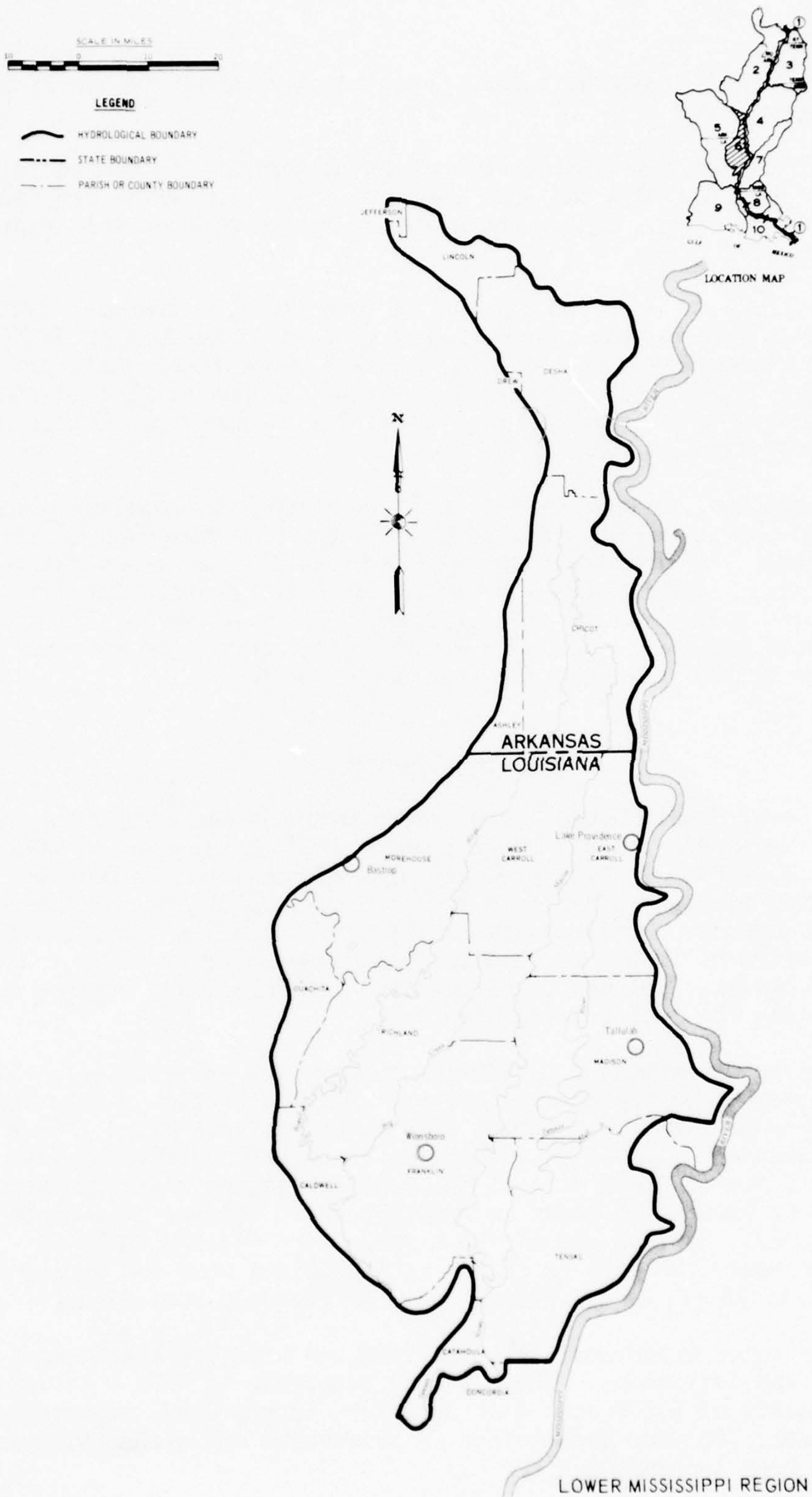
Community 1/	Parish	State	Community Population 1970
Lake Providence	East Carroll	Louisiana	6,183
Winnsboro	Franklin	"	5,349
Tallulah	Madison	"	9,643
Bastrop	Morehouse	"	14,713
Four communities with a total population of:			35,888

1/ Incorporated places (cities, villages, towns, or boroughs) of 5,000 or more inhabitants.

Economy

Total employment in WRPA 6 in 1968 was 53,700. This is an increase of 0.8 percent over 1960. By 2020 the total employment, according to Program A and B projections, is expected to increase to 67,000 and 78,000 respectively. As compared to the other planning areas in the Lower Mississippi Region, WRPA 6 was eighth in total employment in 1968.

Twelve industries that yield wastewaters in relatively large quantities and high BOD concentrations are located in WRPA 6. Food, paper, chemicals and petroleum products industries comprise about 92 percent of the organic waste producing industries in the planning area. Among these four major industrial groups, food and kindred products and



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WATER RESOURCE PLANNING
AREA 6

FIGURE 9

chemical and allied products industries comprise about 42 and 25 percent, respectively.

Table 69 indicates the growth of employment and of industrial water use for Program A and B to the year 2020. The water use indexes are an average of the employment and earnings to more closely represent wastewater production.

Mining operations include fuels and nonmetallic minerals. Natural gas and petroleum are the principal fuels mined. The 1969 production figures for natural gas were 112,813 million cubic feet, while petroleum figures were 17,821 thousand barrels. Among the nonmetallic minerals sand and gravel are the principal ones with a combined production of 293,000 short tons in 1969.

Agricultural production reports of livestock and poultry place cattle and calves and hogs and pigs among the most numerous of large farm animals. In 1970 there were 330,800 cattle and calves and 48,800 hogs and pigs, ranking WRPA 6 sixth in the Lower Mississippi Region with respect to production of cattle and calves and seventh in production of hogs and pigs. Table 70 indicates the projected increase in production to the year 2020 for Programs A and B.

Selected Streams

The Boeuf River, Tensas River, Bayou Barthelomew, Cocodrie Bayou and Bayou Macon receive the largest waste loads discharged in WRPA 6. The flow of streams in this planning area is sustained largely by ground-water seepage, by surface runoff from rainfall and to a minor extent by snowmelt. Their waste assimilative capacities are least during periods of lowest streamflow, which generally occur in the months of August, September, and October with August and October frequently being the most critical months.

Appendix C contains a streamflow summary for selected sites in WRPA 6. Streamflow characteristics are affected by flow regulation and withdrawals for water supply. The recorded flows range from a maximum momentary flow of 26,800 cfs on Bayou LaFourche to minimum momentary flows of 0 cfs at 5 of the 7 stream gaging stations listed. Zero flow is assumed to occur on numerous small streams throughout the planning area. Minimum annual flows range from 414 cfs on Bayou La Fourche near Crew Lake to 12 cfs on Big Colewa near Oak Grove, Louisiana, to 76 cfs on the Tensas River at Tendal, Louisiana.

Major water withdrawals are for fish and wildlife enhancement, industry, and irrigation. There is one reservoir in WRPA 6 having a total capacity of 5,000 acre-feet or more: Turkey Creek reservoir on Turkey Creek. Further information on reservoirs and withdrawals is available from Appendix C.

Table 69 - Employment, WRPA 6

Program	Year	Major Industry Employment	Major Industry Earnings 1/	Indexes Employment	Indexes Earnings	Indexes Water Use
A	1968	53,700	291	100	100	100
	1980	52,000	344	97	118	108
	2000	57,000	710	106	244	175
	2020	67,000	1,554	125	534	330
B	1968	53,700	291	100	100	100
	1980	57,000	378	106	130	118
	2000	66,000	821	123	282	203
	2020	78,000	1,833	145	630	388

1/ In millions of dollars. Industrial water indexes are an average of employment and earnings indexes.

Table 70 - Numbers of Livestock and Poultry, WRPA 6

Livestock and Poultry	1970	Program	1980	2000	2020
Cattle and Calves	330,800	A	421,300	567,100	761,600
		B	421,300	609,200	817,800
Milk Cows	9,200	A	8,400	10,400	12,700
		B	8,400	11,200	13,600
Hogs and Pigs	48,800	A	55,700	72,800	94,500
		B	55,700	78,200	101,500
Sheep and Lambs	11,300	A	8,700	10,200	12,500
		B	8,700	11,000	13,500
Chickens	455,900	A	500,900	641,100	812,100
		B	500,900	688,800	872,100
Broilers	0	A	0	0	0
		B	0	0	0
Turkeys	9,100	A	12,100	17,100	23,100
		B	12,100	18,300	24,800

Major Aquifers

Ground water supplies in WRPA 6 are obtained from aquifers that comprise rock units of Quaternary, and Tertiary age. Aquifers that yield major quantities of water for municipal, industrial, and agricultural use are Quaternary Alluvium, and the Sparta Sand and the Cockfield Formation of Tertiary age.

The water quality of these aquifers is discussed in the next section of this appendix. A listing of aquifers in WRPA 6 is present as part of table 72 of that section. For details regarding the geology of the aquifers, see Appendix C.

PRESENT STATUS

Water Use

Water use for municipal supply, industry and irrigation totalled 222.1 mgd in 1970. Municipal supply accounted for 8.1 mgd (3.6 percent), industrial use for 61.5 mgd (27.7 percent) and irrigation for 152.5 mgd (68.7 percent) of this total. As compared to the other planning areas, WRPA 6 was eight in total water use. By 2020 it is expected that water use for Programs A and B will increase by 81 percent and 100 percent for municipal supply, by 325 and 399 percent for industry and 47 and 67 percent for irrigation.

Cooling water used for thermal electric power generation totalled 0.3 mgd in 1970, and thus constituted a minor water demand in WRPA 6. As compared to the other planning areas, WRPA 6 ranked ninth in total thermal electric cooling water requirements. By 2020 it is expected that this water use will increase almost 22 times for Program A and almost 24 times for Program B.

Water Quality

Surface Water

In WRPA 6 water analyses are available on the Boeuf River, Bayou Macon, and Tensas River. Selected analyses of water sampled under relatively high and low streamflow are listed for these major streams in table 71.

The analyses listed in this table indicate that the rivers in WRPA 6 are calcium bicarbonate type waters with maximum recorded concentrations of 95 mg/1 calcium and 404 mg/1 bicarbonate. These streams are of generally good quality with maximum dissolved solids, sulfate and chloride concentrations of 628, 87 and 137 mg/1, respectively. As indicated in table 127, the recommended limiting concentrations of dissolved solids, sulfate and chloride for drinking waters are 500, 250 and 250 mg/1, respectively.

Ground Water

In WRPA 6 analyses of ground water are available from aquifers of Quaternary , and Tertiary ages. The analyses listed in table 72 represent ranges in chemical composition of well water from each aquifer as based on maximum and minimum concentrations of dissolved solids, sulfate and chloride.

Most aquifers that yield water meeting the recommended limiting concentrations for drinking purposes are of the calcium bicarbonate

Table 71 - Stream Quality, WRPA 6 1/

Stream Sampling Station	Date Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/l)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/l)	Temp. °C
Boeuf River near Ark.-La. State Line	11-21-67	35	82	21	296	50	4.8	38	97	0.1	454	803	7.7		16
	11-19-57	13,100	6.5	2.2	32	2.4	5.2	2.8	3.8	1.0	48	70	6.7		
Bayou Macon on State Hwy. 2 near Oak Grove, Louisiana	10-25-56		48	16	226	20	4.2	20	21	1.0	225	445	7.6		
	11-23-56		22	11	152	11	6.0	13	14	1.2	175	297	8.2		
Boeuf River near Girard, Louisiana	11-15-57	72	95	35	339	---83-	--	87	137	0.0	628	1,060	7.9		
	4-6-57	1,290	7.1	2.2	31	2.7	3.0	4.0	3.0	1.0	43	71.2	6.5		
Tensas River at Tendal, Louisiana	11-21-67	8.8	76	25	404	45	2.6	12	31	0.4	469	711	7.9		14
	3-5-57	342	11	2.9	48	1.6	3.4	3.7	1.5	0.2	58	94.8			
Bayou Macon near Kilbourne, Louisiana	12-6-67	29	73	14	285	23	4.2	25	22	0.1	323	541	7.7		15
	5-22-58	4,220	10	3.2	51	5.7		0.8	1.5	1.5	56	102	6.7		
Bayou Macon near Delhi, Louisiana	9-8-54	56.4	57	25	312	---52-	---	13	62	0.5	348	685	7.7		
	5-23-53	3,420	10	3.2	51	4.4	1.7	2.2	2.0	1.5	59	102	7.3		
Tensas River at Clayton, Louisiana	9-3-68		45	12	200	19	2.5	9.4	22	0.3	236	405	7.7		27
	5-23-68		16	4.9	70	9.4	3.1	7.8	3.7	0.2	82	146	6.7		25

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade)

Table 72 - Ground-Water Quality, WRPA 6 1/

Aquifer System	Well No.	Well Depth (ft.)	Date of Collection	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH	Temperature (°C)
Quaternary															
Alluvium, Undifferentiated	1	110	2-15-52	144	48	429	121	3.6	264	137	2.2	956	1430	7.1	
	2	75	7-15-52	85	16	340	24	2.6	11	24	0.2	369	588	7.2	
Pleistocene Upland Terrace Deposits	3	120	1-31-68	51	9.1	228	13	0.7	0.4	8.0	0.0	227	372	7.9	19
	4	125	1-29-68	19	6.9	102	11	1.0	0.0	14	0.4	139	207	7.4	19
Alluvium Deposits, undifferentiated	5	108	3-28-68	109	60	599	192	4.9	32	291	0.1	1040	1910	7.3	
	6	100	4-29-68	41	15	207	10	1.9	1.8	14	2.1	233	401	7.5	
Tertiary															
Miocene	7	680	3-27-68	1.3	0.4	324	267	3.0	0.0	210	0.9	723	1260	7.6	
	8	320	3-27-68	49	15	379	65	13	12	12	0.0	392	647	7.0	21
Eocene															
Cockfield Formation	9	487	2-8-46	11	2.8	374	345	3.2	0.5	345	0.1	903	1670	7.7	
	10	441	10-16-57	1.3	0.1	170	66	2.2	1.0	8.5	0.0	163	284	8.1	
Sparta Sands	11	773	2-1-68	2.4	0.0	457	476	1.3	0.4	462	0.0	1190	2200	8.5	26
	12	570	11-7-56	0.4	0.1	136	54	2.4	1.4	6.0	1.5	133	225	8.2	

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

type. Exceptions to this are parts of the Miocene Group, the Eocene Group, The Cockfield Formation, and the Sparta Sands, which yield sodium bicarbonate waters.

As indicated in table 72, several aquifers or portions of aquifers yield water exceeding the recommended limiting concentrations for drinking water. The maximum concentrations of these waters range in dissolved solids from 723 mg/l (Miocene) to 1190 mg/l (Sparta Sands), in sulfate (only in a single sample) a concentration of 264 mg/l and (Pleistocene Alluvium) to 462 mg/l (Sparta Sands). Sodium chloride water is the most common type among the aquifers containing excessively mineralized waters. However, sodium bicarbonate and calcium bicarbonate type waters are present in several aquifers.

The recent U. S. Geological Survey study of ground water pollution (4) discusses six occurrences in WRPA 6. The pollutants are natural gas, sulfite and salt water.

In Ouachita Parish, La., near Fairbanks, there is a leaky gas well. In the same parish, near Sicard, ground water has the smell of paper mill sulfite.

In Richland Parish, La., in the Delhi area, ground water pollution is related to old oil well disposal pits frequently used in the early days of oil development. The locations of these pits have never been mapped.

In Tensas Parish, La., near Cooter Point, water with a chloride concentration of 3,000 mg/l was dumped on the ground in the years 1913-1919. In the same parish, near Waterproof, there is a reported condition of salt water coning.

In Concordia Parish, La., near Deer Park, salt water was accidentally injected into a shallow aquifer.

Appendix C shows the altitude of the base of fresh water in the Coastal Plain aquifers of the region. In WRPA 6 the base of fresh water ranges from approximately 1,200 feet below mean sea level in northwestern Desha County, Ark., and from 1,000 feet below mean sea level in southeastern Concordia Parish, La., to a centrally located high of zero feet below mean sea level in Franklin and Madison Parishes, La.

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

Municipal

WRPA 6 has 18 sewered communities of 1,000 or more inhabitants. The total population served in 1970 is estimated at 80,200, as shown in table 73. The total daily raw waste production is 14,440 pounds of BOD. According to Programs A and B, the sewered population is expected to be 104,000 and 114,300 by 2020, which are increases of 30 and 43 percent, respectively. Correspondingly, the total raw BOD waste production will increase to 20,800 pounds per day by 2020 for Program A and to 22,860 for Program B.

Of 18 sewered communities with 1,000 or more inhabitants, there are 12 (67 percent of the WRPA total) that have less than 5,000 inhabitants. The total sewered population of the smaller communities is 33,700 or 42 percent of the total for WRPA 6. The average raw waste production per community is 505 pounds of BOD_5 per day. Five communities (28 percent) are in the range of 5,000 to 9,900 inhabitants and have a total sewered population of 31,800 or 40 percent of the WRPA total. The average raw waste production per community is 1,145 pounds of BOD_5 per day. One community (5 percent) is in the range of 10,000 to 49,900 inhabitants and comprises a sewered population of 14,700 or 18 percent of the total for WRPA 6. The average raw waste production per community is 2,646 pounds of BOD_5 per day.

Many of the sewered communities discharge their effluent to small streams that seasonally have little or no flow. As a consequence, even secondary treatment of sewage may be inadequate and local water quality problems may arise.

Industrial

In 1970 there were 12 industries classified as producing biodegradable wastes in WRPA 6. Major categories involved in this waste production were Food and Kindred Products (42 percent of the total number of industries in WRPA 6), Chemicals and Allied Products (25 percent), Paper and Allied Products (25 percent), and Liquid Gas Petroleum Refining (8 percent).

Industrial waste production is comparatively small in WRPA 6. The 12 industries inventoried are located in or near 6 communities, with Bastrop and Tallulah, Louisiana, being the largest centers. In 1970 the combined municipal (domestic and commercial) and industrial loads discharged to the Boeuf River from Bastrop, and to Tensas River from Tallulah were 74,947 and 1,455 pounds of BOD per day, respectively. At Bastrop, the major industries are paper and allied products. Food canning companies produce the largest quantities of organic wastes in Tallulah.

As shown in table 73, the population equivalent for 1970 will increase from 925,000 to 2,747,400 and 3,230,200 by 2020 according to Programs A and B. These are increases of 297 and 349 percent, respectively. The corresponding raw BOD waste load before treatment of 166,510 pounds per day in 1970 are projected to be 549,470 pounds per day by 2020 for Program A and to 646,050 for Program B.

Agricultural

Among the seven categories of farm animals listed in table 70, cattle and calves is the largest in terms of waste production, accounting for 90 percent of the daily total. There are no broilers. Turkeys is the next smallest category and totals 0.15 percent of the total waste production.

The total daily raw organic wastes produced by livestock and poultry in WRPA 6 in 1970 and estimated for the projected years, is indicated in table 74. As explained in the Regional Summary, agricultural animal wastes generally constitute non-point sources of pollution and the total waste production must, therefore not be equated with BOD loads from municipal and industrial sources.

The total daily production of organic wastes from livestock and and poultry in 1970 was 369,500 pounds of BOD_5. For Programs A and B, this total is expected to increase to 828,100 and 889,200 pounds by the year 2020.

The land area in WRPA 6 affected by erosion in 1970 totalled about 7 percent and ranged from 2 percent along the Tensas River to 10 percent in the Boeuf River Basin. The average gross erosion of the affected areas was 9.4 tons per acre/year and ranged from 7.1 in the Boeuf River Basin to 25.1 tons per acre/year in the Tensas River Basin.

The use of fertilizers on extensive tracts of cultivated land is a significant potential source of nutrients that can be carried to the streams by runoff and wind. Little information is available on this loss of fertilizers; however, it would appear that 10 percent may be a realistic low estimate (18). In 1969 the use of fertilizers in WRPA 6 totalled 86,647 tons, which were applied to 605,761 acres. This averages 286 pounds of fertilizer per acre per year.

There are no figures on the quantities of agricultural pesticides used in the Lower Mississippi River. However, insecticides and herbicides would be used and applied by aerial and land spraying or dusting. The loss of significant quantities of pesticides carried to streams by runoff from rainfall or blown by winds is to be expected, possibly on the same order of magnitude (at least 10 percent) as for loss of fertilizers.

Table 73 - Municipal and Industrial Waste Production, WRPA 6

Load Category	Daily Raw Organic Waste Production 1970	Program	1980	2000	2020
Municipal					
P.E. 1/	80,200	A	83,300	90,500	104,000
		B	88,900	95,200	114,300
#BOD 2/	14,440	A	15,830	18,100	20,800
		B	16,890	19,040	22,860
Industrial					
P.E.	925,000	A	946,500	1,456,900	2,747,400
		B	1,034,100	1,690,000	3,230,200
#BOD	166,510	A	179,830	291,390	549,470
		B	196,480	338,010	646,050
Total					
P.E.	1,005,200	A	1,029,800	1,547,400	2,851,400
		B	1,123,000	1,785,200	3,344,500
#BOD	180,950	A	195,660	309,490	570,270
		B	213,370	357,050	668,910

1/ P.E. - Population equivalents: See Methodology.

2/ #BOD - Pounds of 5-day biochemical oxygen demand.

Table 74 - Organic Wastes from Livestock and Poultry, WRPA 6

	1970	Program	1980	2000	2020
BOD_5 1/	369,500	A	462,200	619,400	828,100
		B	462,200	665,400	889,200

1/ Pounds of 5-day biochemical oxygen demand.

Non-Organic Wastes

In WRPA 6 the non-BOD wastewater discharges from municipal, industrial and agricultural sources are not adequately quantified for discussion. However, present State and Federal discharge permit programs require water quality data which will define the quantities of the wastes that occur at these sources and that are subject to control.

Bacteria

The need for disinfection of sanitary wastes for the control of waterborne diseases, as discussed in the Regional Summary, is indicated in table 75 for WRPA 6.

Table 75 - Flows Containing Harmful Bacteria, WRPA 6

	1970	Program	1980	2000	2020
Flow 1/	6.1	A	6.7	7.9	9.6
		B	7.3	8.3	10.5

1/ Millions of gallons of effluent per day.

EXISTING TREATMENT

Municipal and industrial organic waste treatment levels vary widely between communities and between industries. Average municipal sewage treatment for communities located in WRPA 6 are estimated at 50 percent BOD removal in Louisiana and 80 percent in Arkansas. Total municipal BOD_5 removed by existing treatment in 1970 was 8,340 pounds per day.

Average industrial organic waste treatment is estimated at 55 percent BOD_5 removal throughout the entire region, including WRPA 6. Total industrial BOD_5 removed by existing treatment in 1970 was 91,580 pounds per day.

Agricultural organic wastes are for the most part dispersed over wide areas and generally do not exist as point sources of pollution. Consequently, most wastes are subject to normal practices of land application generally beneficial to soils and crops, but subject to varying degrees of runoff from rainfall and snowmelt.

Disinfection of discharges for disease control are estimated at 75 percent in Louisiana and 10 percent in Arkansas. The total chlorinated discharge in 1970 was 4.6 mgd.

WATER QUALITY CONTROL NEEDS

Water quality control needs exist wherever pollutants are discharged to water supplies. As stated under "Purpose", quantified needs herein are limited to organic or biodegradable wastes, and to bacteria. Organic pollutants are expressed in pounds of BOD_5 per day. Bacterial pollution is expressed in terms of flow in millions of gallons per day requiring treatment.

As explained in "Methodology" municipal and industrial waste loadings are considered point loadings to streams, whereas 95 percent of agricultural loadings are considered non-point sources of pollution. Projected net loadings to streams to the year 2020 are based on calculated total raw waste production minus the quantity of BOD removed or quantity of effluent disinfected by present (1970) treatment held as a constant through the projected 50-year period. Table 76 display future point source municipal and industrial BOD needs. Table 77 displays point source agricultural BOD needs and table 78 shows needs for control of harmful bacteria.

The unsatisfied or net need shown in the 1970 column of the tables indicates that significant pollution control problems exist in WRPA 6 at the present time. The more notable of these problem areas are displayed on figure 3.

Only five percent of the total agricultural BOD waste production is estimated as entering the surface waters as point sources of pollution. The remaining organic wastes are disposed of by such methods as direct land application, recycling, aerated lagoon-irrigation systems. holding tanks, or some combination of these. Nonetheless, the wastes can cause an ultimate surface water problem unless proper land management practices are instituted and maintained.

Bacterial pollution is probably persistent in stream reaches receiving nondisinfected effluent from population centers. In WRPA 6 the total nondisinfected discharge may increase by 2020 more than threefold if present levels of disinfection are maintained.

Table 76 - Municipal and Industrial Organic Pollution Control Needs, WRPA 6

Load Category	1970	Program (Pounds of BOD_5)	1980	2000	2020
Municipal					
Total	14,440	A	15,830	18,100	20,800
Exstg. Trmt.	8,340		8,340	8,340	8,340
Net Need	6,100		7,490	9,760	12,460
		B	16,890	19,040	22,860
			8,340	8,340	8,340
			8,550	10,700	14,520
Industrial					
Total	166,510	A	179,830	291,390	549,470
Exstg. Trmt.	91,580		91,580	91,580	91,580
Net Need	74,930		88,250	199,810	457,890
		B	196,480	338,010	646,050
			91,580	91,580	91,580
			104,900	246,430	554,470
Total					
Total	180,950	A	195,660	309,490	570,270
Exstg. Trmt.	99,920		99,920	99,920	99,920
Net Need	81,030		95,740	209,570	470,350
		B	213,370	357,050	668,910
			99,920	99,920	99,920
			113,450	257,130	568,990

Table 77 - Agricultural Organic Point Source Loads, WRPA 6

	1970	Program	1980	2000	2020
Waste Load 1/	9,000	A	10,800	13,900	18,200
		B	10,800	14,900	19,600

1/ Pounds of 5-day biochemical oxygen demand per day.

Table 78 - Bacterial Pollution Control Needs, WRPA 6

	1970	Program	1980	2000	2020
Total Discharge 1/	6.1	A	6.7	7.9	9.6
Chlorinated	4.6		4.6	4.6	4.6
Net Need	1.5		2.1	3.3	5.0
		B	7.3	8.3	10.5
			4.6	4.6	4.6
			2.7	3.7	5.9

1/ All figures are millions of gallons of effluent per day.

WRPA 7

STUDY AREA DESCRIPTION

General

In 1970 the Big Black planning area (WRPA 7) was ninth in population within the Lower Mississippi Region. According to 1960 economic statistics, WRPA 7 was eighth in manufacturing and seventh in agricultural employment. It was the region's smallest producer of organic wastes from domestic and commercial sources in 1970, comprising 9 sewered communities of 1,000 or more inhabitants with a total population of 48,200 people. The WRPA ranked sixth in total organic wastewater production from industrial sources with 22 industries classified as producing biodegradable wastes in 1970. These industries generated organic wastes equivalent to those produced in an urban center of approximately 1.0 million people. WRPA 7 was seventh in total organic waste production from livestock and poultry. In 1970 this source produced organic wastes equivalent to an urban center of about 2.6 million people (see figure 10).

Water pollution problems in WRPA 7 include: (1) point source discharges of organic wastes that exceed the assimilative capacity of the receiving streams, (2) indeterminate levels of pollution from agricultural organic wastes, fertilizers and pesticides, (3) general bacteriological pollution from non-disinfected effluents, and (4) few instances of ground-water pollution.

Population

WRPA 7 comprises 6,574 square miles in central and southwestern Mississippi. In 1970 a total of 156,000 people inhabited the planning area and by 2020 the population is expected to increase to 217,000 and 254,000 according to respective projections of Programs A and B.

Of the total 1970 population of 156,000, the urban population was 45,000, or 29 percent of the total. Table 79 lists the total and urban populations of WRPA 7 for 1970 and the corresponding projected population for 1980, 2000, and 2020 for Programs A and B.

There are four communities of 5,000 or more inhabitants. These are listed alphabetically by State in table 80 (see figure 10). Natchez, Mississippi, is the largest community with 19,704 inhabitants. In addition, there are seven communities with populations ranging from 1,000 to less than 5,000, and which total 12,800 people.

Table 79 - Population, WRPA 7

Base Population 1970	Programs	Projected Population 1980	2000	2020
Total Population				
	A	162,000	183,000	217,000
156,000	B	179,000	213,000	254,000
Urban Population				
	A	52,000	71,000	98,000
45,000	B	57,000	83,000	114,000

Table 80 - Principal Communities, WRPA 7

Community 1/	County	State	Community Population 1970
Kosciusko	Attala	Mississippi	7,266
Canton	Madison	"	10,503
Winona	Montgomery	"	5,521
Natchez	Adams	"	19,704
Four Communities with a total population of:			42,994

1/ Incorporated places (cities, villages, towns, or boroughs) of 5,000 or more inhabitants.

Economy

Total employment in WRPA 7 in 1968 was 57,950. This is an increase of 15.0 percent over 1959. By 2020 the total employment, according to Programs A and B projections, is expected to increase to 84,000 and 99,000 respectively. As compared to the other planning areas in the Lower Mississippi Region, WRPA 7 was ninth and last in total employment in 1968.

Twenty-two industries that yield wastewaters in relatively large quantities and high BOD concentrations are located in WRPA 7. Food, paper, chemicals and petroleum products industries comprise about 95 percent of the organic waste producing industries in the planning area. Among these four major industrial groups, food and kindred products and paper and allied products comprise about 64 and 23 percent, respectively.

LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WATER RESOURCE PLANNING
AREA 7

FIGURE 10

Table 81 indicates the growth of employment and of industrial water use for Programs A and B to the year 2020. The water use indexes are an average of the employment and earnings.

Mining operations include fuels and nonmetallic minerals. Natural gas and petroleum are the principal fuels mined. The 1969 production figure for natural gas was 3,364 million cubic feet, while petroleum was 22,700 thousand barrels. Among the nonmetallic minerals sand and gravel ranks first in production at 862,000 short tons mined in 1969.

Agricultural production reports of livestock and poultry place cattle and calves and hogs and pigs among the most numerous of large farm animals. In 1970 there were 299,300 cattle and calves and 52,100 hogs and pigs, ranking WRPA 7 eighth in the Lower Mississippi Region with respect to production of cattle and calves and sixth in production of hogs and pigs. Table 82 indicates the projected increase in production to the year 2020 for Programs A and B.

Table 81 - Employment, WRPA 7

		Major Industry		Indexes		
Program	Year	Employment	Earnings 1/	Employment	Earnings	Water Use
A	1968	58,000	246	100	100	100
	1980	60,000	368	103	150	127
	2000	70,000	798	121	324	223
	2020	84,000	1,756	145	714	430
B	1968	58,000	246	100	100	100
	1980	66,000	403	114	164	139
	2000	81,000	923	140	375	258
	2020	99,000	2,071	171	842	507

1/ In millions of dollars. Industrial water indexes are an average of employment and earnings indexes.

Selected Streams

The Big Black River and the Homochitto River receive most of the organic wastes discharged in WRPA 7. The flow of streams in this planning area is sustained largely by ground-water seepage, by surface runoff from rainfall and to a minor extent by snowmelt. Their waste assimilative capacities are least during periods of lowest streamflow, which generally occur in the months of August, September and October with August or October frequently being the most critical months.

Table 82 - Numbers of Livestock and Poultry, WRPA 7

Livestock and Poultry	Numbers of Livestock and Poultry				
	1970	Program	1980	2000	2020
Cattle and Calves	299,300	A	381,200	513,200	689,200
		B	381,200	551,300	740,100
Milk Cows	13,600	A	12,500	15,500	18,900
		B	12,500	16,600	20,300
Hogs and Pigs	52,100	A	59,500	77,700	100,900
		B	59,500	83,500	108,300
Sheep and Lambs	6,100	A	4,700	5,500	6,800
		B	4,700	5,900	7,300
Chickens	2,337,200	A	2,567,600	3,286,800	4,163,500
		B	2,567,600	3,530,800	4,471,100
Broilers	12,418,600	A	17,320,200	24,184,000	32,468,400
		B	17,320,200	25,979,400	34,867,200
Turkeys	2,100	A	2,800	3,900	5,300
		B	2,800	4,200	5,700

Appendix C contains a streamflow summary for selected sites in WRPA 7. Streamflow characteristics are affected by flow regulation and withdrawals for water supply. The recorded flows range from a maximum momentary flow of 141,000 cfs on the Homochitto River at Rosetta, Mississippi, to a daily minimum of 16 cfs on Buffalo River near Woodville, Mississippi. Zero flow is assumed to occur on numerous small streams throughout the planning area. Minimum annual flows range from 794 cfs on the Big Black River near Bovina, Mississippi, to 79 cfs on Buffalo River near Woodville, Mississippi.

Water withdrawals for irrigation and for domestic and industrial purposes are small. There are no reservoirs in WRPA 7 that have a total capacity of 5,000 acre-feet or more. The combined capacity of 21 Soil Conservation Service flood detention structures in Big Black River Basin totals about 8,800 acre-feet. Further information is available from Appendix C.

Major Aquifers

Ground water supplies are obtained from aquifers that comprise rock units of Quaternary, Tertiary and Cretaceous age. Aquifers that yield major quantities of water for municipal, industrial, and agricultural use are the Quaternary alluvium, the Catahoula Sandstone and the Claiborne Group of Tertiary age, and the Eutaw Formation of Cretaceous age.

The water quality of these aquifers is discussed in the next section of this appendix. A listing of aquifers in WRPA 7 is presented as part of table 84 of that section. For details regarding the geology of the aquifers, see Appendix C.

PRESENT STATUS

Water Use

Water use for municipal supply, industry and irrigation totalled 91.0 mgd in 1970. Municipal supply accounted for 12.0 mgd (13.2 percent), industrial use for 73.6 mgd (80.9 percent) and irrigation for 5.4 mgd (5.9 percent) of this total. As compared to the other planning areas in 1970, WRPA 7 was ninth in total water use. By 2020 it is expected that water use for Program A (and Program B) will increase by 173 percent (219 percent) for municipal supply, by 592 percent (681 percent) for industry and 211 percent (343 percent) for irrigation.

Cooling water used for thermal electric power generation totalled 1.0 mgd in 1970. As compared to the other planning areas, WRPA 7 ranked eighth in total thermal electric cooling water requirements. By 2020 it is expected that this water use will increase to 473 mgd for Program A and 554 mgd for Program B.

Water Quality

<u>Surface Water</u>

In WRPA 7 water analyses are available on the Big Black River and the Homochitta River. Selected analyses of water sampled under relatively high and low streamflow are listed for these major streams in table 83.

The analyses listed in this table indicate that the Big Black River at Pickens, Mississippi, has calcium bicarbonate water with maximum recorded concentrations of 6.6 mg/1 calcium and 33 mg/1 bicarbonate. The type of water in the Big Black River changes between Pickens and Port Gibson, Mississippi. At Port Gibson the water has calcium and sodium as the major cations and bicarbonate and chloride as the major anions. Maximum concentrations of these ions has been 21 mg/1 and 55 mg/1 respectively for calcium and sodium and 82 mg/1 and 96 mg/1 respectively for bicarbonate and chlorides. The water of the Homochitto River at Rosetta, Mississippi, contains only one major cation, sodium, and two major anions, bicarbonate and chloride. Maximum concentrations of these ions has been 12 mg/1 for sodium and 19 mg/1 and 18 mg/1, respectively, for bicarbonate and chloride. These streams are of generally good quality with maximum dissolved solids, sulfate and chloride concentrations of 256, 9.4 and 96 mg/1, respectively. As indicated in table 127, the recommended limiting concentrations of dissolved solids, sulfate and chloride for drinking water are 500, 250 and 250 mg/1, respectively.

<u>Ground Water</u>

In WRPA 7 analyses of ground water are available from aquifers of Quaternary, Tertiary, and Cretaceous ages. The analyses listed in table 84 represent ranges in chemical composition of well water from

Table 83 - Stream Quality, WRPA 7 1/

Stream Sampling Station	Date Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/1)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/1)	Temp. °C
Big Black River at Pickins, Mississippi	5-18-65 8-24-65	173 281	6.6 4.0	3.3 2.2	33 22	8.3 5.1	1.1 2.5	9.4 7.2	8.1 5.2	0.2 1.9	68 51	103 87	6.1 5.7		
Big Black River near Port Gibson Mississippi	10-19-61 8-29-62		21 17	8.2 6.5	82 78	55 18	3.9 2.4	7.8 7.2	96 28	1.4 0.2	256 142	455 234	7.2 6.7		
Homochitto River at Rosetta, Mississippi	4-4-67 6-6-67	367 371	4.0 3.9	1.2 1.0	19 15	12 4.9	1.6 0.9	3.4 0.2	18 8.8	0.1 0.0	62 38	91 55	6.5 6.2		

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade)

Table 84 - Ground-Water Quality, WRPA 7 1/

Aquifer System	Well No.	Well Depth (ft.)	Date of Collection	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH	Temperature (°C)
Quaternary															
Mississippi River Alluvium	1	215	9-27-61	82	46	488	11	2.3	8.8	6.5	0.5	415	682	8.0	
	2	245	9-27-61	62	30	328	17	2.5	10	29	0.7	330	565	7.6	
Tertiary															
Pliocene															
Citronelle Formation	3	60	1-21-14	34	27	41			25	361	0.0	692			
	4	130	7-16-19	2	1.4	15			1.2	11	3.9	59			
Miocene															
Miocene Series, Undifferentiated	5	274	7-16-62	44	21	214	446	16	14	707	0.2	1460	2630	6.7	29
	6	237	6-21-63	2.4	0.0					2.0		18		5.4	19
Catahoula Sandstone	7	508	7-3-68	3.2	1.5	536	225	1.8	5.2	33	0.0	624	955	8.4	21
	8	79	3-13-70	7.9	2.7	306	115	5.5	16	11	0.0	392	520	7.2	
Eocene															
Claiborne Group															
Cockfield Formation	9	680	6-13-58	0.6	1.1	268	142	7.0	51	32	0.2	414	585	7.9	26
	10	462	10-26-56	16	6.1	153	47	3.8	30	7.5	0.7	209	327	8.4	21
Sparta Sand	11	943	9-12-56	9.5	33	3110	3490	24	1.0	160	2.6	15200	9950	7.0	22
	12	975	10-12-60	5.5	1.2		41		13	6		115		6.4	
Winona Sand	13	168	2-1-57	40	18	105	14	9.8	23	12	2.7	225	393	8.5	18
Tallahatta Formation	14	204	1-10-57	6.8	2.4	35	3.3	2.9	6.8	2.5	0.5	100	77	6.5	
Meridian Sand Member	15	314	1-14-57	8.3	4.4	42	4.4	2.5	12	4	0.3	108	104	6.8	18
Tallahatta Siltstone															
Meridian-Upper Wilcox Aquifer	16	477	2-16-71	3.0	0.4	186	68	1.2	3.6	2.9	0.2	188	289	7.5	
	17	136	2-26-57	5.7	2.6	30	3.5	1.4	4.0	3.5	0.0	36	70	7.5	
Wilcox Group															
Tuscahoma Formation															
Middle Wilcox Aquifer	18	280	6-18-69	3.9	0.3	194	70	1.6	1.6	5.9	0.0	201	308	7.4	19
	19	561	11-7-63	19	6.2	108	11	4	7.2	2.8	0.4	135	193	7.3	
Nanafalia Formation															
Lower Wilcox Aquifer	20	320	8-19-11	46	10	215	42	0.0	42	22	40	300			
	21	173	6-10-60	5.9	2.2	90	22	3.8	0.0	2.0	0.2	142	138	7.1	18
Cretaceous-Upper															
Eutaw Formation (unrestricted)	22	1486	7-20-61	4.9	2.5	638	394	3.0	10	248	1.5	1070	1780	8.1	
	23	1120	6-10-60	4.6	0.7	348	182	4.4	1.4	95	1.3	520	836	8.0	22
McShan Formation	24	1720	3-19-62	5.0	2.7	538	346	2.9	2.2	234	1.1	962	1640	7.8	
Tuscaloosa Group															
Gordo Formation	25	2194	11-30-66	16	3.2	175	285	3.2	0.8	378	0.1	789	1430	7.2	32
	26	1870	11-18-70	20	1.2	132	148	5.5	0.0	193	0.3	446	842	7.3	
Coker Formation	27	2233	11-18-70	20	2.0	163	230	6.0	0.2	302	0.2	655	1230	7.8	
	28	1698	11-18-70	13	2.3	133	136	5.3	0.0	165	0.3	401	741	7.3	

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

each aquifer as based on maximum and minimum concentrations of dissolved solids, sulfates and chlorides.

The aquifers that yield water meeting the recommended limiting concentrations for drinking purposes yield calcium bicarbonate or sodium ium bicarbonate water.

As indicated in table 84, several aquifers or portions of aquifers yield water exceeding the recommended limiting concentrations for drinking water. The maximum concentrations of these waters range in dissolved solids from 624 mg/1 (Catahoula Sandstone) to 15,200 mg/1 (Sparta Sand) and in chlorides from 302 mg/1 (Coker Formation) to 707 mg/1 (Miocene Series, Undifferentiated). Sulfate concentrations are low. Sodium bicarbonate water is the most common type among these aquifers containing excessively mineralized waters. However, sodium chloride and calcium bicarbonate waters are present in several aquifers. Aquifers that can yield highly mineralized water include the Miocene Series, (Undifferentiated), the Sparta Sand, the Eutaw Formation, the McShan Formation, the Gordo Formation, and the Coker Formation.

The recent U. S. Geological Survey study of ground water pollution (4) discusses two occurrences in WRPA 7. The pollutants are oil field brines.

In Adams County, Mississippi, about 10 miles southeast of Natchez, several water wells are contaminated by oil field water.

In Wilkinson County, Mississippi, about five miles northeast of the town of Wilkinson, a salt spring near the southern end of Homochitto National Forest is suspected to have originated from oil field water. The U. S. Geologic Survey is planning dye tests to ascertain the source of pollution.

Appendix C, shows the altitude of the base of fresh water in the Coastal Plain aquifers of the region. In WRPA 7 the base of fresh water ranges from more than 2,000 feet below mean sea level to about 500 feet below mean sea level.

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

Municipal

WRPA 7 has 9 sewered communities of 1,000 or more inhabitants. The total population served in 1970 is estimated at 48,200, as shown in table 85. The total daily raw waste production is 8,680 pounds of BOD. According to Programs A and B, the sewered population is expected to be 88,100 and 102,900 by 2020, which are increases of 83 and 113 percent, respectively. Correspondingly, the total raw BOD waste production will increase to 17,620 pounds per day by 2020 for Program A and to 20,580 for Program B.

Of the 9 sewered communities with 1,000 or more inhabitants, there are 6 (66.7 percent of the WRPA total) that have less than 5,000 inhabitants. The total sewered population of these smaller communities is 10,700 or 22.2 percent of the total for WRPA 7. The average raw waste production per community is 321 pounds of BOD per day. One community (11 percent) is in the range of 5,000 to 9,900 inhabitants and has a total sewered population of 7,300 or 15 percent of the WRPA total. The average raw waste production per community is 1,314 pounds of BOD per day. Two communities (22 percent) are in the range of 10,000 to 49,900 inhabitants and comprise a sewered population of 30,200 or 63 percent of the total for WRPA 7. The average raw waste production per community is 2,718 pounds of BOD per day.

Many of the sewered communities discharge their effluent to small streams that seasonally have little or no flow. As a consequence, even secondary treatment of sewage may be inadequate and local water quality problems may arise.

Industrial

In 1970 there were 22 industries classified as producing biodegradable wastes in WRPA 7. Major categories involved in this waste production were Food and Kindred Products, (64 percent of the total number of industries in WRPA 7), Paper and Allied Products (23 percent), Chemicals and Allied Products (9 percent) and Rubber and Plastics Products (4 percent).

Industrial waste production is comparatively small in WRPA 7. The 22 industries inventoried are located in or near 8 communities, with Natchez and Pickens, Mississippi, being the largest centers. In 1970 the combined municipal (domestic and commercial) and industrial loads discharged to the Big Black River from Pickens, and to the Mississippi River from Natchez were 1,466 and 81,203 pounds of BOD per day, respectively. Companies producing paper and allied products produce the largest quantities of organic wastes in both cities.

As shown in table 85, the population equivalent for 1970 will increase from 989,000 to 3,827,600 and 4,513,000 by 2020 according to Programs A and B. These are increases of 287 and 356 percent, respectively. The corresponding raw BOD waste load before treatment of 178,030 pounds per day in 1970 are projected to be 765,520 pounds per day by 2020 for Program A and 902,600 for Program B.

Agricultural

WRPA 7 ranks seventh in the Lower Mississippi Region in total organic waste production from livestock and poultry. Among the seven categories of farm animals listed in table 82, cattle and calves is the largest in terms of waste production, accounting for 65 percent of the daily total. Turkeys is the smallest category and totals 0.03 percent of the total waste production.

The total daily raw organic wastes produced by livestock and poultry in WRPA 7 in 1970, and estimated for the projected years, is indicated in table 86. As explained in the Regional Summary, agricultural animal wastes generally constitute non-point sources of pollution and total waste production must, therefore, not be equated with BOD loads from municipal and industrial sources.

The total daily production of organic wastes from livestock and poultry in 1970 was 462,500 pounds of BOD_5. For Programs A and B this total is expected to increase to 1,036,700 and 1,113,200 pounds by the year 2020.

The land area in WRPA 7 affected by erosion in 1970 totalled about 66 percent and ranged from 64.1 percent in the Black River Basin to 72.4 percent in the Homochitto River Basin. The average gross erosion of the affected areas was 8.0 tons per acre/year and ranged from 7.1 in the Big Black River Basin to 12.4 tons per acre/year in the Homochitto River Basin.

The use of fertilizers on extensive tracts of cultivated land is a significant potential source of nutrients that can be carried to the streams by runoff and wind. Little information is available on this loss of fertilizers; however, it would appear that 10 percent may be a realistic low estimate (18). In 1969 the use of fertilizers in WRPA 7 totalled 47,265 tons, which were applied to 251,502 acres. This averages 376 pounds of fertilizer per acre per year.

There are no compiled figures on the quantities of agricultural pesticides used in the Lower Mississippi Region. However, insecticides and herbicides are applied by aerial and land spraying or dusting. The loss of significant quantities of pesticides carried to streams by runoff from rainfall or blown by winds is to be expected, possibly on the same order of magnitude (at least 10 percent) as for loss of fertilizers.

Table 85 - Municipal and Industrial Organic Waste Production, WRPA 7

Load Category	Daily Raw Organic Waste 1970	Program	1980	2000	2020
Municipal					
P. E. 1/	48,200	A	52,800	66,900	88,100
		B	58,500	77,800	102,900
#BOD 2/	8,680	A	10,030	13,380	17,620
		B	11,120	15,560	20,580
Industrial					
P. E.	989,000	A	1,190,000	1,985,000	3,827,600
		B	1,302,400	2,296,600	4,513,000
#BOD	178,030	A	226,100	397,000	765,520
		B	247,460	459,310	902,600
Total					
P. E.	1,037,200	A	1,242,800	2,051,900	3,915,700
		B	1,360,900	2,374,400	4,615,900
#BOD	186,710	A	236,130	410,380	783,140
		B	258,580	474,870	923,180

1/ P. E. - Population equivalents: See Methodology.
2/ #BOD - Pounds of 5-day biochemical oxygen demand.

Table 86 - Organic Wastes from Livestock and Poultry, WRPA 7

	1970	Program	1980	2000	2020
BOD_5 1/	462,500	A	579,700	779,000	1,036,700
		B	579,700	836,800	1,113,200

1/ Pounds of 5-day biochemical oxygen demand .

Non-Organic Wastes

In WRPA 7 the non-BOD wastewater discharges from municipal, industrial and agricultural sources are not adequately quantified for discussion. However, present State and Federal discharge permit programs require water quality data which will define the quantities of the wastes that occur at these sources and that are subject to control.

Bacteria

The need for disinfection of sanitary wastes for the control of waterborne diseases, as discussed in the Regional Summary, is indicated in table 87 for WRPA 7.

Table 87 - Flows Containing Harmful Bacteria, WRPA 7

	1970	Program	1980	2000	2020
Flow 1/	6.4	A	8.1	10.8	15.2
		B	9.0	12.6	17.8

1/ Millions of gallons of effluent per day.

EXISTING TREATMENT

Municipal and industrial organic waste treatment levels vary widely between communities and between industries. Average municipal sewage treatment for communities located in WRPA 7 are estimated at 50 percent in the State of Mississippi. Total municipal BOD_5 removed by existing treatment in 1970 was 4,340 pounds per day.

Average industrial organic waste treatment is estimated at 55 percent BOD_5 removal throughout the entire region, including WRPA 7. Total industrial BOD_5 removed by existing treatment in 1970 was 97,920 pounds per day.

Agricultural organic wastes are for the most part dispersed over wide areas and generally do not exist as point sources of pollution. Consequently, most wastes are subject to normal practices of land application generally beneficial to soils and crops, but subject to varying degrees of runoff from rainfall and snowmelt.

Disinfection of discharges for disease control are estimated at 30 percent in Mississippi. The total chlorinated discharge in 1970 was 1.9 mgd.

WATER QUALITY CONTROL NEEDS

Water quality control needs exist wherever pollutants are discharged to water supplies. As stated under "Purpose," quantified needs herein are limited to organic or biodegradable wastes, and to bacteria. Organic pollutants are expressed in pounds of BOD_5 per day. Bacterial pollution is expressed in terms of flow in millions of gallons per day requiring treatment.

As explained in "Methodology" municipal and industrial waste loadings are considered point loadings to streams, whereas 95 percent of agricultural loadings are considered non-point sources of pollution. Projected net loadings to streams to the year 2020 are based on calculated total raw waste production minus the quantity of BOD removed or quantity of effluent disinfected by present (1970) treatment held as a constant through the projected 50-year period. Table 88 displays future point source municipal and industrial BOD needs. Table 89 displays point source agricultural BOD needs and table 90 shows needs for control of harmful bacteria.

The unsatisfied or net need shown in the 1970 column of the tables indicates that significant pollution control problems exist in WRPA 7 at the present time. The more notable of these problem areas are displayed on figure 3.

Only 5 percent of the total agricultural BOD waste production is estimated as entering the surface waters as point sources of pollution. The remaining organic wastes are disposed of by such methods as direct land application, recycling, aerated lagoon-irrigation systems, holding tanks, or some combination of these. Nonetheless, the wastes can cause an ultimate surface water problem unless proper land management practices are instituted and maintained.

Bacterial pollution is probably persistent in stream reaches receiving nondisinfected effluent from population centers. In WRPA 7 the total nondisinfected discharge may increase by 2020 about threefold if present levels of disinfection are maintained.

Table 88 - Municipal and Industrial Organic Pollution Control Needs, WRPA 7

Load Category	1970	Program	1980	2000	2020
			(Pounds of BOD_5)		
Municipal					
Total	8,680	A	10,030	13,380	17,620
Exstg. Trmt.	4,340		4,340	4,340	4,340
Net Need	4,340		5,690	9,040	13,280
		B	11,120	15,560	20,580
			4,340	4,340	4,340
			6,780	11,220	16,240
Industrial					
Total	178,030	A	226,100	397,000	765,520
Exstg. Trmt.	97,920		97,920	97,920	97,920
Net Need	80,110		128,180	299,080	667,600
		B	247,460	459,310	902,600
			97,920	97,920	97,920
			149,540	361,390	804,680
Total					
Total	186,710	A	236,130	410,380	783,140
Exstg. Trmt.	102,260		102,260	102,260	102,260
Net Need	84,450		133,870	308,120	680,880
		B	258,580	474,870	923,180
			102,260	102,260	102,260
			156,320	372,610	820,920

Table 89 - Agricultural Organic Point Source Loads, WRPA 7

	1970	Program	1980	2000	2020
Waste Load 1/	18,780	A	22,960	30,720	40,350
		B	22,960	32,990	43,330

1/ Pounds of 5-day biochemical oxygen demand per day.

Table 90 - Bacterial Pollution Control Needs, WRPA 7

	1970	Program	1980	2000	2020
Total Discharge 1/	6.4	A	8.0	10.8	15.2
Chlorinated	1.9		1.9	1.9	1.9
Net Need	4.5		6.1	8.9	13.3
		B	8.9	12.6	17.8
			1.9	1.9	1.9
			7.0	10.7	15.9

1/ All figures are millions of gallons of effluent per day.

W R P A 8

STUDY AREA DESCRIPTION

General

In 1970 the Baton Rouge planning area (WRPA 8) was seventh in population within the Lower Mississippi Region. According to 1960 economic statistics, WRPA 8 was fifth in manufacturing and eighth in agricultural employment. It was the region's sixth largest producer of organic wastes from domestic and commercial sources in 1970, comprising 16 sewered communities of 1,000 or more inhabitants with a total population of 259,000 people. The WRPA ranked fourth in total amount of organic wastewater production from industrial sources with 97 industries classified as producing biodegradable wastes in 1970. These industries generated organic wastes equivalent to those produced in an urban center of approximately 2.0 million people. WRPA 8 was sixth in total organic waste production from livestock and poultry. In 1970 this source produced organic wastes equivalent to an urban center of about 2.9 million people.

Water pollution problems in WRPA 8 include: (1) point source discharges of organic wastes that exceed the assimilative capacity of the receiving streams, including the Mississippi River, which receives most of the wastewater discharges from WRPA 8, (2) non-organic industrial discharges to the Mississippi River, (3) indeterminate levels of pollution from agricultural organic wastes, fertilizers, and pesticides, (4) general bacterial pollution from non-disinfected effluents, and (5) instances of ground water pollution.

Population

WRPA 8 comprises 5,705 square miles in southwestern Mississippi and southeastern Louisiana. In 1970 a total of 547,000 people inhabited the planning area and by 2020 the population is expected to increase to 1,003,000 and 1,139,000 according to the respective projections of Programs A and B (see figure 11).

Of the total 1970 population of 547,000, the urban population was 317,000, or 58 percent of the total. Table 91 lists the total and urban populations of WRPA 8 for 1970 and the corresponding projected population for 1980, 2000, and 2020 for Programs A and B.

There are seven communities of 5,000 or more inhabitants. These are listed alphabetically by state in table 92 (see figure 11). Baton Rouge, Louisiana, is the largest community with 165,963 inhabitants. In addition, there are 21 communities with populations ranging from 1,000 to less than 5,000, and which total 50,800 people.

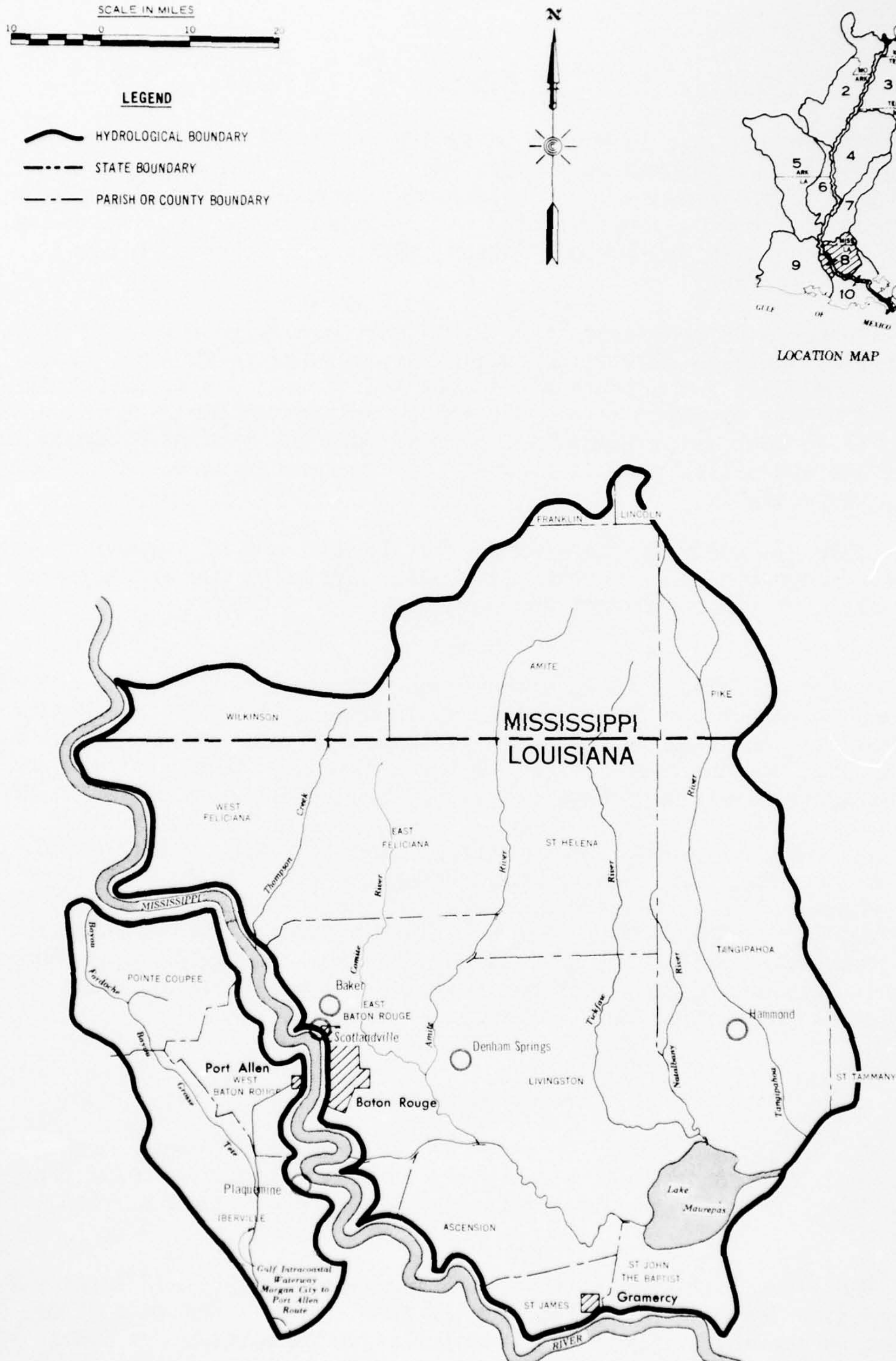
Table 91 - Population, WRPA 8

Base Population 1970	Programs	Projected Population 1980	2000	2020
Total Population				
	A	618,000	782,000	1,003,000
547,000	B	666,000	876,000	1,139,000
Urban Population				
317,000	A	377,000	532,000	733,000
	B	406,000	596,000	831,000

Table 92 - Principal Communities, WRPA 8

Community 1/	Parish	State	Community Population 1970
Scotlandville	E. Baton Rouge	Louisiana	22,557
Baton Rouge	E. Baton Rouge	"	165,963
Baker	E. Baton Rouge	"	8,281
Plaquemine	Iberville	"	7,739
Denham Springs	Livingston	"	6,752
Hammond	Tangipahoa	"	12,487
Port Allen	W. Baton Rouge	"	5,728
Seven communities with a total population of:			229,507

1/ Incorporated places (cities, villages, towns, or boroughs) of 5,000 or more inhabitants.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WATER RESOURCE PLANNING
AREA 8

FIGURE 11

AD-A041 361 LOWER MISSISSIPPI REGION COMPREHENSIVE STUDY COORDINA--ETC F/G 8/6
LOWER MISSISSIPPI REGION COMPREHENSIVE STUDY. APPENDIX L. WATER--ETC(U)
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Economy

Total employment in WRPA 8 in 1968 was 178,334. This is an increase of 26.1 percent over 1959. By 2020 the total employment, according to Programs A and B projections, is expected to increase to 386,000 and 455,000, respectively. As compared to the other planning areas in the Lower Mississippi Region, WRPA 8 was seventh in total employment in 1968.

Ninety-seven industries that yield wastewaters in relatively large quantities and high BOD concentrations are located in WRPA 8. Food, paper, chemicals and petroleum products industries comprise about 98 percent of the organic waste producing industries in the planning area. Among these four major industrial groups, food and kindred products and chemicals and allied products industries comprise about 51 and 37 percent, respectively.

Table 93 indicates the growth of employment and of industrial water use for Program A and B to the year 2020. The water use indexes are an average of the employment and earnings.

Mining operations include fuels and nonmetallic minerals. Natural gas and petroleum are the principal fuels mined. The 1969 production figure for natural gas was 91,071 million cubic feet, while petroleum was 29,950 thousand barrels. Among the nonmetallic minerals sand and gravel ranks first in production at 5,525,000 short tons mined in 1969.

Agricultural production reports of livestock and poultry place cattle and calves and hogs and pigs among the most numerous of large farm animals. In 1970 there were 324,100 cattle and calves and 43,500 hogs and pigs, ranking WRPA 8 seventh in the Lower Mississippi Region with respect to production of cattle and calves and eighth in production of hogs and pigs. Table 94 indicates the projected increase in production to the year 2020 for Programs A and B.

Selected Streams

The Tangipahoa River, Amite River, Choctaw Bayou, Lower Grand River and Thompson's Creek receive the largest organic waste discharges in WRPA 8, exclusive of the Mississippi River, which is discussed in WRPA 1.

The flow of streams in this planning area is sustained largely by groundwater seepage, by surface runoff from rainfall and to a minor extent by snowmelt. Their waste assimilative capacities are least during periods of lowest streamflow, which generally occur in the months of September, and October with October frequently being the most critical month.

Table 93 - Employment, WRPA 8

Program	Year	Major Industry Employment	Earnings1/	Indexes Employment	Earnings	Water Use
A	1968	178,300	1,094	100	100	100
	1980	213,000	1,800	119	165	142
	2000	288,000	4,148	161	379	265
	2020	386,000	9,528	217	871	544
B	1968	178,300	1,094	100	100	100
	1980	233,000	1,974	131	180	156
	2000	333,000	4,798	187	439	313
	2020	455,000	11,237	255	1,027	641

1/ In millions of dollars. Industrial water use indexes are an average of employment and earnings indexes.

Table 94 - Numbers of Livestock and Poultry, WRPA 8

Livestock and Poultry	Numbers of Livestock and Poultry 1970	Program	1980	2000	2020
Cattle and Calves	324,100	A	412,800	555,600	746,200
		B	412,800	596,900	801,300
Milk Cows	76,500	A	70,300	86,800	106,000
		B	70,300	93,200	113,800
Hogs and Pigs	43,500	A	49,600	64,800	84,200
		B	49,600	69,600	90,400
Sheep and Lambs	3,400	A	2,600	3,100	3,800
		B	2,600	3,300	4,100
Chickens	2,217,000	A	2,435,600	3,117,800	3,949,400
		B	2,435,600	3,349,200	4,241,100
Broilers	5,293,000	A	7,382,100	10,307,600	13,838,500
		B	7,382,100	11,072,800	14,860,900
Turkeys	4,900	A	6,500	9,200	12,400
		B	6,500	9,900	13,300

Appendix C contains a streamflow summary for selected sites in WRPA 8. Streamflow characteristics are affected by flow regulation and withdrawals for water supply. The recorded flows range from a maximum momentary flow of 67,000 cfs on the Amite River near Denham Springs, Louisiana, to a minimum momentary flow of 0 cfs on Black Bayou near Duplessis, Louisiana. Zero flow is assumed to occur on numerous small streams throughout the planning area. The mean flows range from 1,824 cfs on the Amite River near Denham Springs to 4 cfs on Black Bayou near Duplessis.

Water withdrawals are for fish and wildlife conservation and for industrial and municipal uses. There are no reservoirs in WRPA 8 that have a total capacity of 5,000 acre-feet or more. Further information is available from Appendix C.

Major Aquifers

Ground water supplies are obtained from aquifers that comprise rock units of Quaternary and Tertiary age. Aquifers that yield major quantities of water for municipal, industrial and agricultural use are the Mio-Pliocene Sands, the Pleistocene Group, and the Mississippi River Valley Alluvium of Holocene and Pleistocene age.

The water quality of these aquifers is discussed in the next section of this appendix. A listing of aquifers in WRPA 8 is presented as part of table 96 of that section. For details regarding the geology of the aquifers, see Appendix C.

PRESENT STATUS

Water Use

Water use for municipal supply, industry and irrigation totalled 1570.9 mgd in 1970. Municipal supply accounted for 55.2 mgd (3.5 percent), industrial use for 1514.2 mgd (96.4 percent) and irrigation for 1.5 mgd (0.1 percent) of this total. As compared to the other planning areas in 1970, WRPA 8 was fourth in total water use. By 2020 it is expected that water use for Program A (and Program B) will increase by 186 percent (224 percent) for municipal supply by 814 percent (978 percent) for industry and 860 percent (1353 percent for irrigation).

Cooling water used for thermal electric power generation totalled 588.4 mgd in 1970, and thus constituted the second largest water demand in WRPA 8. As compared to the other planning areas, WRPA 8 ranked third in total thermal electric cooling water requirements. By 2020 it is expected that this water use will increase 858 percent for Program A and 987 percent for Program B.

Water Quality

Surface Water

In WRPA 8 water analyses are available on the Tangipahoa River and the Amite River. Selected analyses of water sampled under relatively high and low streamflow are listed for these major streams in table 95.

The analyses listed in this table indicate that the rivers in WRPA 8 are sodium bicarbonate type waters with the exception being the Amite River below Port Vincent where sodium chloride waters prevail. The maximum recorded concentrations are 102 mg/l sodium, 32 mg/l bicarbonate and 181 mg/l chloride, all recorded at Port Vincent on the Amite River. These streams are of good quality with maximum dissolved solids, sulfate and chloride concentrations of 371, 6.6 and 181 mg/l, respectively. As indicated in table 127, the recommended limiting concentrations of dissolved solids, sulfate and chloride for drinking water are 500, 250 and 250 mg/l, respectively.

Ground Water

In WRPA 8 analyses of ground water are available from aquifers of Quaternary and Tertiary ages. The analyses listed in table 96 represent ranges in chemical composition of well water from each aquifer as based on maximum and minimum concentrations of dissolved solids, sulfate and chloride.

Table 95 - Stream Quality, WRPA 8 [1/]

Stream Sampling Station	Date Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/1)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/1)	Temp. °C
Tangipahoa River at Tangipahoa, Louisiana	11-28-67	290	2.6	0.4	14	6.0	1.5	0.6	8.1	0.1	39	49			14
Tangipahoa River at Robert, Louisiana	3-1-68 7-17-68	824 317	3.1 2.0	0.1 1.2	14 16	5.2 4.7	2.8 0.5	0.2 2.2	6.9 4.7	0.5 0.2	36 36	52 45			11 27
Tangipahoa River near Ponchatoula, Louisiana	1-21/31-64 4-25/5-2-64	1,170 5,910	3.2 2.3	0.5 0.8	10 10	4.8 2.5	1.6 1.3	3.2 0.8	7.3 3.8	1.4 0.4	56 23	54 39	6.0 5.9		11-14 22-27
Amite River near Darlington, Louisiana	6-22-68 2-28-68	270 352	2.8 2.1	0.2 0.2	14 12	4.3 5.0	0.6 0.9	2.2 0.4	4.2 5.4	0 0.1	38 31	36 35			26 11
Amite River at Magnolia, Louisiana	11-9-66		1.9	0.8	14	5.4	1.0	0.0	5.7	0.1	33	41	6.7		
Amite River near Denham Springs, Louisiana	6-4-68 2-27-68	587 636	4.0 2.8	1.2 0.7	18 15	4.3 6.0	1.2 0.9	1.2 2.2	6.7 8.0	0.1 0.1	50 36	55 53	6.5 6.9		28 11
Amite River near Port Vincent, Louisiana	3-31-65 9-24-68		16 2.9	2.7 1.2	32 20	102 9.0	8.0 2.0	6.6 3.2	181 11	1.1 0.2	371 49	821 71	7.0 6.3		27
Amite River at S.H. 22 near Maurepas, Louisiana	11-14-67		12	6.1	23	80	2.7	11	146	0.3	305	552			18
Amite River Diversion Channel near St. Paul, Louisiana	11-14-67		8.0	1.9	23	42	1.8	4.2	72	0.3	166	294			18

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade)

Table 96 - Ground-Water Quality, WRPA 8 1/

Aquifer System	Well No.	Well Depth (ft.)	Date of Collection	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH	Temperature (°C)
Quaternary															
Alluvium	1	232	7-10-68	53	13	251	11	1.8	0.0	5.2	2.5	232	396	7.6	
Pleistocene															
Gonzales Aquifer	2	509	1-10-68	16	2.9	168	89	1.1	4.8	72	0.0	317	507	7.9	24
Tertiary-Pliocene															
1200 Foot Sand	3	1322	11-14-67	0.7	0.5	160	67	0.2	9.6	3.2	0.0	183	279	8.0	28
1500 Foot Sand	4	1739	8-9-68	0.4	0.0	176	72	0.4	11	4.2	0.4	201	302	8.0	
Tertiary-Miocene															
2000 Foot Sand	5	1470	12-7-67	1.3	0.2	193	93	0.4	13	2.7	0.0	243	377	8.6	
2400 Foot Sand	6	2368	11-8-67	1.2	0.2	205	84	0.4	8.8	3.1	0.5	225	347	7.9	33
2800 Foot Sand	7	2808	11-8-67	0.4	0.0	279	108	0.3	9.6	3.1	0.0	277	456	8.2	31
Tertiary															
Pliocene	8	608	7-24-68	2.0	0.5	157	63	0.4	11	3.6	1.1	195	275	8.0	23
	9	640	7-25-68	2.2	1.1	19	4.5	1.0	0.6	3.5	0.0	45	44	6.4	
Miocene	10	2504	1-8-68	2.8	0.2	256	238	0.6	4.2	193	0.0	604	1090	8.7	33
	11	2008	7-26-68	0.0	0.0	137	58	0.7	10	3.0	0.0	178	244	7.9	

1/Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

Most aquifers that yield water meeting the recommended limiting concentrations for drinking purposes yield sodium bicarbonate water. An exception to this is the Quaternary Alluvium which yields calcium bicarbonate waters.

As indicated in table 96 the only aquifer exceeding recommended limiting concentrations for drinking water was the Miocene. A maximum dissolved solids concentration of 604 mg/l was recorded for that aquifer.

The recent U. S. Geological Survey study of ground water pollution (4) discusses five occurrences in WRPA 8. The pollutants are salt water, sewage, and poultry wastes.

In Pike County, Mississippi, north of McComb, wastes from a poultry plant have been dumped in a gravel pit.

In Pointe Coupee Parish, Louisiana, a chloride buildup in a well at Livonia was reported in 1964.

In East Baton Rouge Parish, Louisiana, at Baton Rouge, salt water movement through several aquifers has been measured. First reported in 1966 the salty waters in the "600-foot", "1,200-foot", and "1,500-foot" sands are moving at rates of 320, 310 and 240 feet per year.

In Ascension Parish, Louisiana, salt water is coned up by pumping and was first reported in 1956 at Gonzales and in 1958 at Geismar. The chloride concentration of well water at Gonzales increased from 10 to 392 mg/l in four years. To avoid this problem a new well was drilled. At Geismar, the chloride concentration increased from 50 to 434 mg/l in six months. The chloride concentration returns to normal when the well is not pumped.

Appendix C shows the altitude of the base of fresh ground water in the Coastal Plain aquifers of the region. In WRPA 8 the base of fresh water ranges from more than 3,500 feet below mean sea level in southeastern Tangipahoa Parish to less than 500 feet below mean sea level in Ascension Parish. Intermediate beds may contain salt water in a narrow belt generally paralleling the Mississippi River from south of Baton Rouge toward New Orleans.

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

Municipal

WRPA 8 has 16 sewered communities of 1,000 or more inhabitants. The total population served in 1970 is estimated at 259,000, as shown in table 97. The total daily raw waste production is 46,620 pounds of BOD. According to Programs A and B, the sewered population is expected to be 576,900 and 654,400 by 2020, which are increases of 123 and 153 percent, respectively. Correspondingly, the total raw BOD waste production will increase to 115,380 pounds per day by 2020 for Program A and to 130,880 for Program B.

Of the 16 sewered communities with 1,000 or more inhabitants, there are 8 (50 percent of the WRPA total) that have less than 5,000 inhabitants. The total sewered population of these smaller communities is 24,400 or 9.4 percent of the total for WRPA 8. The average raw waste production per community is 549 pounds of BOD_5 per day. Five communities (31 percent) are in the range of 5,000 to 9,900 inhabitants and have a total sewered population of 33,500 or 13 percent of the WRPA total. The average raw waste production per community is 1,206 pounds of BOD_5 per day. Two communities (12.5 percent) are in the range of 10,000 to 49,900 inhabitants and comprise a sewered population of 35,100 to 13.5 percent of the total for WRPA 8. The average raw waste production per community is 3,159 pounds of BOD_5 per day. One community (6.4 percent) is in the range of 100,000 or more inhabitants and has a sewered population of 166,000 or 64 percent of the WRPA total. The raw waste production is 29,880 pounds of BOD_5 per day.

Many of the sewered communities discharge their effluent to small streams that seasonally have little or no flow. As a consequence, even secondary treatment of sewage may be inadequate and local water quality problems may arise.

Industrial

In 1970 there were 97 industries classified as producing biodegradable wastes in WRPA 8. Major categories involved in this waste production were Food and Kindred Products (50 percent of the total number of industries in WRPA 8), Chemicals and Allied Products (37 percent), Paper and Allied Products (5 percent), Petroleum and Coal Products (5 percent), Liquid Gas and Petroleum Refining (1 percent), and Lumber and Wood Products (1 percent).

Industrial organic waste production is heavy in WRPA 8. The 97 industries inventoried are located in or near 22 communities, with the Baton Rouge area (including Baker, Zackary and Scotlandville) and Hammond. The Baton Rouge area discharges to the Mississippi

River and because of the large assimilative capacity are not considered to constitute a water quality need. In 1970 the combined municipal (domestic and commercial) and industrial load discharge to Lake Maurepas via Ponchatoula Creek from Hammond was 19,914 pounds of BOD_5 per day.

As shown in table 97, the population equivalent for 1970 in WRPA 8 will increase from 1,987,800 to 9,732,300 and 11,467,700 by 2020 according to Programs A and B. These are increases of 390 and 477 percent, respectively. The corresponding raw BOD waste load before treatment of 357,810 pounds per day in 1970 is projected to be 1,946,470 pounds per day by 2020 for Program A and 2,293,540 for Program B.

Agricultural

WRPA 8 ranks sixth in the Lower Mississippi Region in total organic waste production from livestock and poultry. Among the seven categories of farm animals listed in table 94, cattle and calves is the largest in terms of waste production, accounting for 62 percent of the daily total. Turkeys is the smallest category and totals .05 percent of the total waste production.

The total daily raw organic wastes produced by livestock and poultry in WRPA 8 in 1970, and estimated for the projected years, is indicated in table 98. As explained in the Regional Summary, agricultural animal wastes generally constitute non-point sources of pollution and the total waste production must, therefore, not be equated with BOD loads from municipal and industrial sources.

The total daily production of organic wastes from livestock and poultry in 1970 was 522,000 pounds of BOD_5. For Programs A and B this total is expected to increase to 1,087,500 and 1,167,400 pounds by the year 2020. The land area in WRPA 8 affected by erosion in 1970 totalled about 33 percent and ranged from 1.8 percent along the Atchafalaya River to 63.3 percent in the Mississippi River Basin. The average gross erosion of the affected areas was 8.0 tons per acre/year and ranged from 1.1 in the Atchafalaya River Basin to 8.9 tons per acre/year in the Amite River Basin.

The use of fertilizers on extensive tracts of cultivated land is a significant potential source of nutrients that can be carried to the streams by runoff and wind. Little information is available on this loss of fertilizers; however, it would appear that 10 percent may be a realistic low estimate (18). In 1969 the use of fertilizers in WRPA 8 totalled 50,661 tons, which were applied to 272,725 acres. This averages 371 pounds of fertilizer per acre per year.

Table 97 - Municipal and Industrial Organic Waste Production, WRPA 8

Load Category	Daily Raw Organic Waste Production 1970	Program	1980	2000	2020
Municipal					
P.E. 1/	259,000	A	304,700	419,200	576,900
		B	328,200	468,900	654,400
#BOD 2/	46,620	A	57,890	83,840	115,380
		B	62,360	93,780	130,880
Industrial					
P.E.	1,987,800	A	2,674,100	4,740,900	9,732,300
		B	2,937,800	5,599,700	11,467,700
#BOD	357,810	A	508,090	948,190	1,946,470
		B	558,180	1,119,930	2,293,540
Total					
P.E.	2,246,800	A	2,978,800	5,160,100	10,309,200
		B	3,266,000	6,068,600	12,122,100
#BOD	404,430	A	565,980	1,032,030	2,061,850
		B	620,540	1,213,710	2,424,420

1/ P.E. - Population equivalents: See Methodology.

2/ #BOD - Pounds of 5-day biochemical oxygen demand.

Table 98 - Organic Wastes from Livestock and Poultry, WRPA 8

	1970	Program	1980	2000	2020
BOD_5 1/	522,000	A	622,100	824,900	1,087,500
		B	622,100	886,100	1,167,400

1/ Pounds of 5-day biochemical oxygen demand per day.

There are no compiled figures on the quantities of agricultural pesticides used in the Lower Mississippi Region. However, insecticides and herbicides are applied by aerial and land spraying or dusting. The loss of significant quantities of pesticides carried to streams by runoff from rainfall or blown by winds is to be expected, possibly on the same order of magnitude (at least 10 percent) as for loss of fertilizers.

Non-Organic Wastes

In WRPA 8 non-BOD wastewaters from industrial sources are discharged in large quantities to the Mississippi River and are discussed in WRPA 1. Many of the industries have initiated abatement programs as required by the State of Louisiana and by the Refuse Act Program of the Environmental Protection Agency.

Bacteria

The need for disinfection of sanitary wastes for the control of waterborne diseases, as discussed in the Regional Summary, is indicated in table 99 for WRPA 8.

Table 99 - Flows Containing Harmful Bacteria, WRPA 8

	1970	Program	1980	2000	2020
Flow 1/	33.6	A	45.6	69.6	101.5
		B	49.1	77.8	115.5

1/ Millions of gallons of effluent per day.

EXISTING TREATMENT

Municipal and industrial organic waste treatment levels vary widely between communities and between industries. Average municipal sewage treatment for communities located in WRPA 8 are estimated at 50 percent BOD removal in Louisiana and in Mississippi. Total municipal BOD_5 removed by existing treatment in 1970 was 23,310 pounds per day.

Average industrial organic waste treatment is estimated at 55 percent BOD_5 removal throughout the entire region, including WRPA 8. Total industrial BOD_5 removed by existing treatment in 1970 was 196,800 pounds per day.

Agricultural organic wastes are for the most part dispersed over wide areas and generally do not exist as point sources of pollution. Consequently, most wastes are subject to normal practices of land application generally beneficial to soils and crops, but subject to varying degrees of runoff from rainfall and snowmelt.

Disinfection of discharges for disease control are estimated at 75 percent in Louisiana and 30 percent in Mississippi. The total chlorinated discharge in 1970 was 25.2 mgd.

WATER QUALITY CONTROL NEEDS

Water quality control needs exist wherever pollutants are discharged to water supplies. As stated under "Purpose", quantified needs herein are limited to organic or biodegradable wastes, and to bacteria. Organic pollutants are expressed in pounds of BOD_5 per day. Bacterial pollution is expressed in terms of flow in millions of gallons per day requiring treatment.

As explained in "Methodology" municipal and industrial waste loadings are considered point loadings to streams, whereas 95 percent of agricultural loadings are considered non-point sources of pollution. Projected net loadings to streams to the year 2020 are based on calculated total raw waste production minus the quantity of BOD removed or quantity of effluent disinfected by present (1970) treatment held as a constant through the projected 50-year period. Table 100 displays future point source municipal and industrial BOD needs. Table 101 displays point source agricultural BOD needs and table 102 shows needs for control of harmful bacteria.

The unsatisfied or net need shown in the 1970 column of the tables indicates that significant pollution control problems exist in WRPA 8 at the present time. The more notable of these problems areas are displayed on figure 3.

Only five percent of the total agricultural BOD waste production is estimated as entering the surface waters as point sources of pollution. The remaining organic wastes are disposed of by such methods as direct land application, recycling, aerated lagoon-irrigation systems, holding tanks, or some combination of these. Nonetheless, the wastes can cause an ultimate surface water problem unless proper land management practices are instituted and maintained.

Bacterial pollution is probably persistant in stream reaches receiving nondisinfected effluent from population centers. In WRPA 8 the total nondisinfected discharge may increase by 2020 more than ninefold if present levels of disinfection are maintained.

Table 100 - Municipal and Industrial Organic Pollution Control Needs, WRPA 8

Load Category	1970	Program	1980	2000	2020
		(Pounds of BOD_5)			
Municipal					
Total	46,620	A	57,890	83,840	115,380
Exstg. Trmt.	23,310		23,310	23,310	23,310
Net Need	23,310		34,580	60,530	92,070
		B	62,360	93,780	130,880
			23,310	23,310	23,310
			39,050	70,470	107,570
Industrial					
Total	357,810	A	508,090	948,190	1,946,470
Exstg. Trmt.	196,800		196,800	196,800	196,800
Net Need	161,010		311,290	751,390	1,749,670
		B	558,180	1,119,930	2,293,540
			196,800	196,800	196,800
			361,380	923,130	2,096,740
Total					
Total	404,430	A	565,980	1,032,030	2,061,850
Exstg. Trmt.	220,110		220,110	220,110	220,110
Net Need	184,320		345,870	811,920	1,840,740
		B	620,540	1,213,710	2,424,420
			220,110	220,110	220,110
			400,430	993,600	2,204,310

Table 101 - Agricultural Organic Point Source Loads, WRPA 8

	1970	Program	1980	2000	2020
Waste Load 1/	22,253	A	24,462	31,791	40,863
		B	24,462	34,153	43,877

1/ Pounds of 5-day biochemical oxygen demand per day.

Table 102 - Bacterial Pollution Control Needs, WRPA 8

	1970	Program	1980	2000	2020
Total Discharge 1/	33.6	A	45.6	69.5	101.5
Chlorinated	25.2		25.2	25.2	25.2
Net Need	8.4		20.4	44.3	76.3
		B	49.1	77.8	115.4
			25.2	25.2	25.2
			23.9	52.6	90.2

1/ All figures are millions of gallons of effluent per day.

W R P A 9

STUDY AREA DESCRIPTION

General

In 1970 the Lake Charles-Lafayette planning area (WRPA 9) was fourth in population within the Lower Mississippi Region. According to 1960 economic statistics, WRPA 9 was seventh in manufacturing and fourth in agricultural employment. It was the region's third largest producer of organic wastes from domestic and commercial sources in 1970 comprising 50 sewered communities of 1,000 or more inhabitants with a total population of 448,800 people. The WRPA ranked third in total organic wastewater production from industrial sources with 120 industries classified as producing biodegradable wastes in 1970. These industries generated organic wastes equivalent to those produced in an urban center of approximately 2.3 million people. WRPA 9 was fourth in total organic waste production from livestock and poultry. In 1970 this source produced organic wastes equivalent to an urban center of about 3.8 million people (See figure 12).

Water pollution problems in WRPA 9 include: (1) point source discharges of organic wastes that exceed the assimilative capacity of the receiving streams, (2) non-organic industrial discharges in the Calcasieu River Basin, (3) indeterminate levels of pollution from agricultural organic wastes, fertilizers and pesticides, (4) general bacterial pollution from non-disinfected effluents, and (5) instances of ground water pollution.

Population

WRPA 9 comprises 13,296 square miles in southwestern Louisiana. In 1970 a total of 748,000 people inhabited the planning area and by 2020 the population is expected to increase to 994,000 and 1,117,000 according to the respective projections of Programs A and B.

Of the total 1970 population of 748,000, the urban population was 434,000, or 58 percent of the total. Table 103 lists the total and urban populations of WRPA 9 for 1970 and the corresponding projected population for Programs A and B.

There are 19 communities of 5,000 or more inhabitants. These are listed alphabetically by state in table 104. Lake Charles, Louisiana is the largest community with 77,998 inhabitants. In addition, there are 35 communities with populations ranging from 1,000 to less than 5,000, and which total 82,300 people.

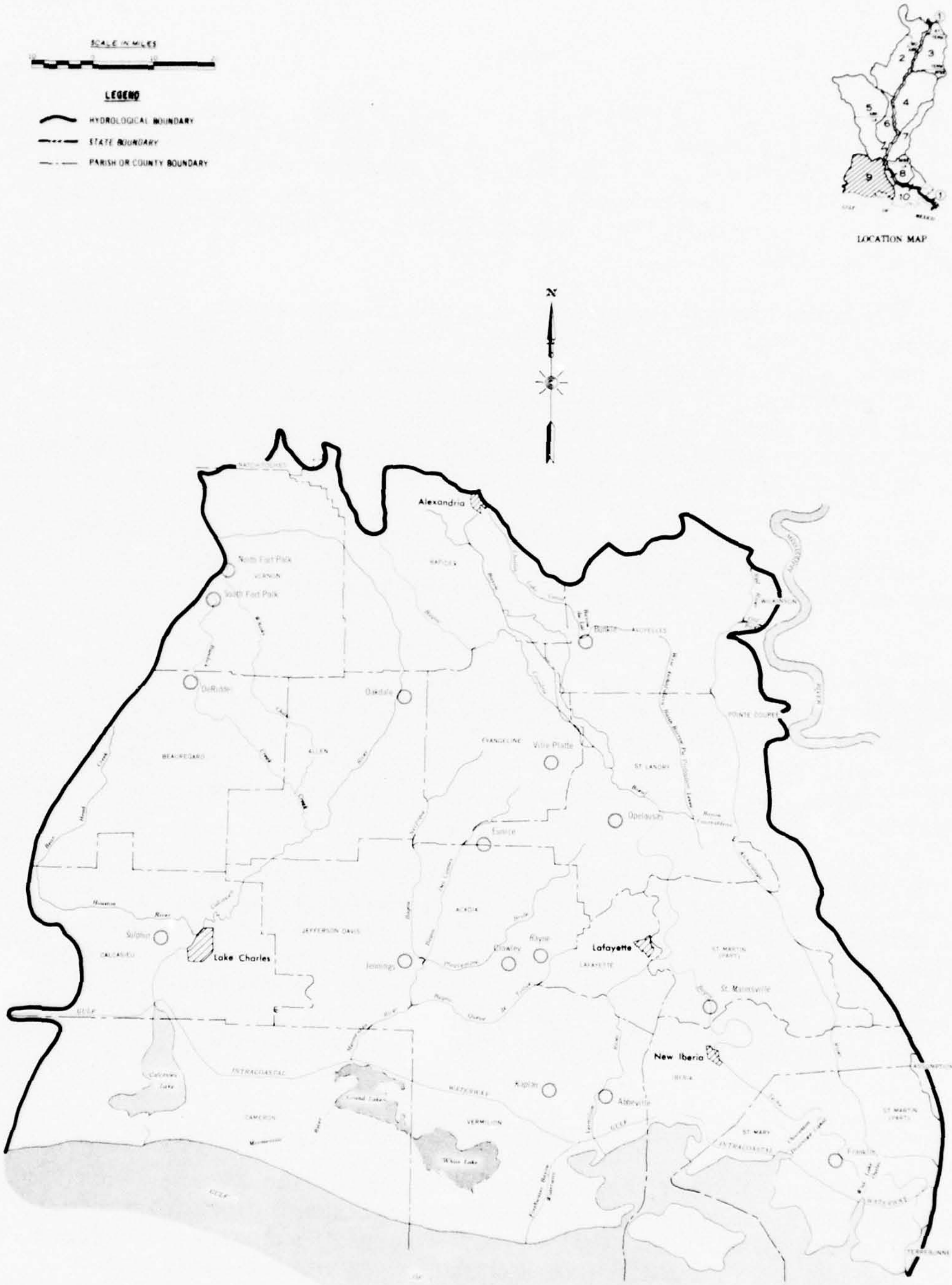
Table 103 - Population, WRPA 9

Base Population 1970	Programs	Projected Population 1980	2000	2020
Total Population				
	A	770,000	860,000	994,000
748,000	B	824,000	973,000	1,117,000
Urban Population				
434,000	A	477,000	576,000	716,000
	B	511,000	652,000	804,000

Table 104 - Principal Communities, WRPA 9

Community 1/	Parish	State	Community Population 1970
Abbeville	Vermilion	Louisiana	10,996
Bunkie	Avoyelles	"	5,395
Crowley	Acadia	"	16,104
DeRidder	Beauregard	"	8,030
Eunice	Acadia-St. Landry	"	11,390
Franklin	St. Mary	"	9,325
Jennings	Jefferson Davis	"	11,783
Kaplan	Vermilion	"	5,540
Lafayette	Lafayette	"	68,908
Lake Charles	Calcasieu	"	77,998
New Iberia	Iberia	"	30,147
North Fort Polk	Vernon	"	7,955
Oakdale	Allen	"	7,301
Opelousas	St. Landry	"	20,121
Rayne	Acadia	"	9,510
St. Martinville	St. Martin	"	7,153
South Fort Polk	Vernon	"	15,600
Sulphur	Calcasieu	"	13,551
Ville Platte	Evangeline	"	9,692
Nineteen communities with a total population of:			346,489

1/ Incorporated places (cities, villages, towns, or boroughs) of 5,000 or more inhabitants.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WATER RESOURCE PLANNING
AREA 9

FIGURE 12

Economy

Total employment in WRPA 9 in 1968 was 253,643. This is an increase of 29.9 percent over 1959. By 2020 the total employment, according to Program A and B projections, is expected to increase to 360,000 and 425,000 respectively. As compared to the other planning areas in the Lower Mississippi Region WRPA 9 was fourth in total employment in 1968.

One hundred twenty industries that yield wastewaters in relatively large quantities and high BOD concentrations are located in WRPA 9. Food, paper, chemicals and petroleum products industries comprise about 94 percent of the organic waste producing industries in the planning area. Among these four major industrial groups, food and kindred products and chemical and allied products industries comprise about 58 and 21 percent, respectively.

Table 105 indicates the growth of employment and of industrial water use for Programs A and B to the year 2020. The water use indexes are an average of the employment and earnings.

Mining operations include fuels and nonmetallic minerals. Natural gas and petroleum are the principal fuels mined. The 1969 production figure for natural gas was 3,613,000 million cubic feet, while petroleum was 288,424 thousand barrels. Among the nonmetallic minerals salt ranks first in production at 6,981,000 short tons mined in 1969, while sand and gravel ranks second in production at 2,437,000 short tons.

Agricultural production reports of livestock and poultry place cattle and calves and hogs and pigs among the most numerous of large farm animals. In 1970 there were 534,400 cattle and calves and 135,600 hogs and pigs, ranking WRPA 9 fourth in the Lower Mississippi Region with respect to production of cattle and calves and fourth in production of hogs and pigs. Table 106 indicates the projected increase in production to the year 2020 for Programs A and B.

Selected Streams

The Calcasieu River, Mermentau River, Vermilion River, Bayou Teche and the Atchafalaya River receive the largest discharges of organic wastes in WRPA 9. Their flow is largely sustained by ground water seepage and by runoff from rainfall. An exception is the Atchafalya River, which is a distributary of water from the Red River and the Mississippi River. The Gulf Intracoastal Waterway borders the coastal marshes in an east-west direction. A lock system minimizes interflow between drainage basins and salt water intrusion.

Table 105 - Employment, WRPA 9

Program	Year	Major Industry Employment	Major Industry Earnings 1/	Indexes Employment	Indexes Earnings	Indexes Water Use
A	1968	253,600	1,397	100	100	100
	1980	263,000	2,019	104	145	125
	2000	303,000	4,028	120	288	204
	2020	360,000	8,222	142	589	366
B	1968	253,600	1,397	100	100	100
	1980	288,000	2,213	114	158	136
	2000	350,000	4,659	138	334	236
	2020	425,000	9,697	167	694	431

1/ In millions of dollars. Industrial water use indexes are an average of employment and earnings indexes.

Table 106 - Numbers of Livestock and Poultry, WRPA 9

Livestock and Poultry	1970	Program	1980	2000	2020
Cattle and Calves	534,400	A	680,600	916,100	1,230,300
		B	680,600	984,100	1,321,200
Milk Cows	41,400	A	38,000	46,900	57,300
		B	38,000	50,400	61,500
Hogs and Pigs	135,600	A	154,700	202,100	262,400
		B	154,700	217,100	281,800
Sheep and Lambs	89,300	A	68,500	80,600	99,200
		B	68,500	86,600	106,500
Chickens	1,587,200	A	1,743,700	2,232,100	2,827,400
		B	1,743,700	2,397,800	3,036,300
Broilers	1,313,800	A	1,832,400	2,558,500	3,434,900
		B	1,832,400	2,748,400	3,688,700
Turkeys	4,700	A	6,300	8,800	11,900
		B	6,300	9,500	12,800

The waste assimilative capacities of these streams are least during periods of lowest streamflow, which generally occur in September and October, with October frequently being the most critical month.

Appendix C contains a streamflow summary for selected sites in WRPA 9. Streamflow characteristics are affected by flow regulation and withdrawals for water supply. The recorded flows range from a maximum momentary flow of 741,000 cfs on the Atchafalaya River near Morgan City, Louisiana, to a minimum momentary flow of 0 cfs on numerous streams including Bayou Teche at Keystone Lock. Zero flow is assumed to occur on numerous small streams throughout the planning area. The mean flows range from 181,400 cfs on the Atchafalaya River at Krotz Spring to 25.8 cfs on Bayou Bourbeaux at Shuteston, Louisiana.

Heavy withdrawals of surface water are for industry and irrigation. The water used for industry was mostly brackish. Other uses were for fish and wildlife preservation, electric power plants, and mineral resources industry. There are four reservoirs in WRPA 9 that individually have a total capacity of 5,000 acre-feet or more. Further information is available from Appendix C.

Major Aquifers

Ground water supplies in WRPA 9 are obtained from aquifers that comprise rock units of Quaternary age.

Southwestern Louisiana has a thick sequence of interbedded gravels, sands, silts, and clays that are divided into the Atchafalaya, Chicot, Evangeline, and Jasper aquifers. The Chicot aquifer is the principal source of fresh ground water.

The water quality of these aquifers is discussed in the next section of this appendix. A listing of aquifers in WRPA 9 is presented as part of table 108 of that section. For details regarding the geology of the aquifers, see Appendix C.

PRESENT STATUS

Water Use

Water use for municipal supply, industry and irrigation totalled 2859.5 mgd in 1970. Municipal supply accounted for 72.0 mgd (2.5 percent), industrial use for 1301.5 mgd (45.5 percent) and irrigation for 1486.0 mgd (52.0 percent) of this total. As compared to the other planning areas in 1970, WRPA 9 was second in total water use. By 2020 it is expected that water use for Programs A and B will increase by 133 percent and 162 percent for municipal supply, by 728 and 877 percent for industry and decrease by 8.5 and 0.2 percent for irrigation.

Cooling water used for thermal electric power generation totalled 336.5 mgd in 1970, and thus constituted the fourth largest water demand in WRPA 9. As compared to the other planning areas, WRPA 9 ranked sixth in total thermal electric cooling water requirements. By 2020 it is expected that this water use will increase 845 percent for Program A and 965 percent for Program B.

Water Quality

Surface Water

In WRPA 9 water analyses are available on the Calcasieu River, Mermentau River, Atchafalaya River, Vermilion River, Bayou Nezpique, Bayou Des Canne, Bayou Teche, and Bayou Boeuf. Selected analyses of water sampled under relatively high and low stream flow are listed for these major streams in table 107.

Where these streams are not significantly affected by oil field brines, industrial wastes, municipal sewage or salt water encroachment from the Gulf of Mexico, the streams are very similar in quality. The waters are relatively low in total mineralization (generally less than 160 mg/1 total dissolved solids) and have sodium and bicarbonate as the predominant cation and anion.

The large diversion of surface water for irrigation causes salt water to move several miles upstream in the Calcasieu and Vermilion Rivers. In the case of the Calcasieu River this distance is 40 miles where it may remain for considerable periods after the pumping season is over. This may cause crop losses and create a potential hazard of groundwater pollution. Control structures have been installed on the Calcasieu, Mermentau, and Vermilion Rivers to decrease the adverse affects of salt water encroachment.

Ground Water

The chemical quality of water from wells tapping the Chicot aquifer, Evangeline aquifer, and alluvial sand is listed in table 108. Of the nine samples, two are from the Chicot, three are from the Evaneline, and four are from the various alluvial sands.

The water from these aquifer systems is generally more highly mineralized than surface waters. Total dissolved solids range from 118 mg/1 to 1,150 mg/1.

The chloride concentrations in ground water from the Chicot aquifer system increase down dip and toward the Gulf of Mexico. For example, chloride concentrations in northern Beauregard and Allen Parishes are generally less than 20 mg/1. In central Cameron Parish chloride concentrations exceed 200 mg/1.

The recent U. S. Geological Survey study of ground water pollution (4) discusses eight occurrences in WRPA 9. The pollutants are salt water and methane gas.

In Cameron and Vermilion Parishes, Louisiana, it was reported in 1957 that the northward movement of connate salt water was 50 feet per year in the Chicot aquifer between White and Grand Lakes.

In Calcasieu Parish near Lake Charles, it was reported before 1924 that methane gas escaped upward through a deep "dry hole" into the "700-foot", "500-foot" and "200-foot" sands. Heavy ground water withdrawals from those sands will probably cause the lateral spread of methane in solution.

In five oil and gas fields in Calcasieu, Cameron and Acadia Parishes, La., there were high methane concentrations in ground water reported in the mid-1940's. In the early 1950's a minor explosion occurred in the municipal plant in Jeanerette. (When ground water at 74°F contains more than 1.1 mg/1 methane, an explosion hazard exists.)

In Vermilion Parish, Louisiana, the salt water interface was reported in 1964 to be moving northward. The rates of movement are reported to be 200 feet/year in the "700-foot" sand, 70 feet/year in the "500-foot" sand, and 30 feet/year in the upper sand unit.

In Vermilion Parish, Louisiana, eight miles south of Abbeville, salt river water infiltrates the aquifer where the clay bottom is cut.

Appendix C shows the altitude of the base of fresh water in the Coastal Plain aquifers of the region. In WRPA 9 the base of fresh water ranges from less than 500 feet below mean sea level in much of the southern area to more than 3,000 feet below mean sea level centering in southeastern Vernon Parish.

Table 107 - Stream Quality, WRPA 9 1/

Stream Sampling Station	Date Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO4)	Chloride (Cl)	Nitrate (NO3)	Dissolved Solids (mg/l)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/l)	Temp. °C
Calcasieu River near Hineston, Louisiana	9-17-68	44	4.0	0.5	14	4.3		0.2	5.0	0.0	37	46			
Calcasieu River near Glenmora, Louisiana	5-1-68	1170	2.0	1.2	9	2.4		2.8	1.5	0.2	21	30			
	6-1-60	39	9.5	1.5	36	8.3		8.2	7.2	0.0		92	6.0		
Calcasieu River Oakdale Bridge, Louisiana	Minimum 2/ 58-65					2	1.0	2.2	2.3			33.7	6.1	4.2	6
	Maximum 2/ 58-65					48.5	9.5	15.6	44.1			286	7.7	11.0	31.5
Calcasieu River near Oberlin, Louisiana	10-30-67	309	10.0	0.7	120	44	1.6	20	5.3	1.2	155	262	6.9		20
	1-29-68	1470	2.1	0.7	10	3.4	1.0	3.2	4.6	0.1	28	37	6.5		11
Calcasieu River near Kinder, Louisiana	10-30-67	921	2.8	0.7	20	6.0	5.2	3.8	5.4	0.1	37	57			
	9-9-68	1160	4.6	1.3	40	12	3.8	6.0	5.0	0.2	73	90			23
	Minimum 2/ 58-65					2	1.0	4.0	3			43.9	6.2	5.8	7
	Maximum 2/ 58-65					29	10.7	22	44.1			447	8.4	10.8	23
Calcasieu River near Lake Charles, Louisiana	4-21/30-49		1.1	0.9	10	4.1		1	4.0	0.5		29	6.9		
Calcasieu River Moss Bluff (now at US 171 Bridge), Louisiana	Minimum 2/ 58-65					3	1.0	9.6	15.0			39	5.8	3.4	6.5
	Maximum 2/ 58-65					1050	89.5	203.1	3425.0			6706	7.8	14	33
Mermentau River at Mermentau, Louisiana	6-16-53		4.4	2.0	30	8.1	2.0	1.2	9.0	0.2		80	6.8		
Mermentau River at US 90, Louisiana	Minimum 2/ 59-65					9	2	9.9	9.5			97	6.2	1.9	8
	Maximum 2/ 59-65					158	11	41.2	250			1286	8.0	9.5	34
Mermentau River at Lake Arthur, Louisiana	12-14/15-49		6.2	1.5	12	2.1		4	7.0	2.8		60	6.5		
	10-21/27-50		16	19	69	151		28	254	1.5		988	7.2		
Bayou Nezpique near Basile, Louisiana	3-28-68	1540	3.1	1.0	14	5.0	2.2	1.2	6.8	0.5	31	56			14
Bayou Des Canne near Eunice, Louisiana	3-28-68	29	11	3.0	48	21	4.0	8.2	29	0.1	110	212			18
Bayou Teche at Arnaudville, Louisiana	3-27-68	1120	9.0	4.3	47	5.9	2.5	4.8	7.3	0.5	65	114			14
	11-16-55	170	21	7.7	113	19		7.0	18	0.8		244	7.5		
Bayou Teche at Breaux Bridge, Louisiana	Minimum 2/ 58-65					4	2.0	5.6	1.2			94.1	6.2	2.0	8
	Maximum 2/ 58-65					158	18.6	29.1	225			925	8.5	9.6	30

Table 107 - Stream Quality, WRPA 9 (Cont'd) 1/

Stream Sampling Station	Date Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/l)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/l)	Temp. °C
Bayou Teche at Morbinham, Louisiana	9-2-58		10	2.7	42	6.4	3.6	7.8	6	1.2		103	6.6		
Bayou Teche at Olivier, Louisiana	9-2-58		14	2.7	57	7.4	4.2	5.6	9	1.3		131	6.7		
Bayou Teche at Franklin, Louisiana	Minimum 2/	58-65				10.5	2.0	31.9	12			191.6	6.3	3.4	8
	Maximum 2/	58-65				124	11.5	80.3	215			1059	8.2	9.3	31
Bayou Boeuf near Alexandria at Kincad Bridge, Louisiana	8-7-57		2.2	1.0	15	4.9	0.8	0.4	4.8	0.5		51	5.5		
Vermilion River at Lafayette Louisiana	4-5-'44		10	4.4	41	38	4.2	3.0	64	1.8		289	7.5		
Vermilion River at Lafayette Airport Bridge Louisiana	Minimum 2/	58-65				9.5	2.5	10.7	10.1			130	6.4	1.0	7.5
	Maximum 2/	58-65				576	12.5	75.6	1550			9444	7.8	8.8	31
Vermilion River at at Abbeville, Louisiana	5-20-53								7.0			66			
	5-2-53								119			473			
Vermilion River at Bancker Ferry near Abbeville, Louisiana	3-18/21/24/25/30-49		6.5	7.1	26	26		3.3	54	1.2		232	7.5		
	9-9/19-51		80	202	68	1640		405	2920			9350	7.5		
Vermilion River at Perry Bridge, Louisiana	Minimum 2/	58-65				12	3	12.4	12.6			35	6.3	1.8	8
	Maximum 2/	58-65				174	12.5	35	1683			2063	8.3	8.0	30
Atchafalaya River at Simmesport, Louisiana	4-18-53		22	6.6	71	15	2.4	24	22	3.5		244	7.8		
	9-17-52		45	15	159	36	3.2	57	43	3.0		508	7.8		
Atchafalaya River at Krotz Springs, Louisiana	Minimum 2/	58-65				10	2	6.5	16.4			257.2	6.9	3.7	5
	Maximum 2/	58-65				114	10	81.2	181			964	8.6	12.3	33
	6-1/10-53	367,800	21	4.9	74	11		14	14	1.8		199	7.6		
	12-11/20-53	50,260	47	16	144	92		54	148	1.8		803	7.9		
(Intracoastal Waterway) Bayou Bouef near Morgan City, Louisiana	5-20-56		37	10	115	49	5.3	19	89	1.4		512	7.4		

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

2/ Maximum and Minimum values in analyses run from 1958 to 1965 by the Louisiana Wildlife and Fisheries-Stream Control Commission.

Table 108 - Ground-Water Quality, WRPA 9 1/

Aquifer System	Well No.	Well Depth (ft.)	Date of Collection	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH	Temperature (°C)
Quaternary Alluvial	1	1470	12-7-67	1.3	0.2	193	93	0.4	13	2.7	0.0	243	377	8.6	
2000 Foot Sand	2	1872	12-4-67	1.1	0.5	176	94	0.2	12	6.8	0.2	255	410	8.9	31
2800 Foot Sand	3	150	7-17-68	74	42	395	30	1.3	14	57	0.1	459	778	8.0	
	4	332	7-31-68	4.7	1.0	521	265	1.7	1.0	111	0.0	688	1160	8.1	
Chicot	5	129	2-26-68	14	3.7	70	11	1.3	3.4	7.8	1.2	118	149	6.4	
	6	460	10-24-49	27	16	420	-----401-------		0.3	470	2.0	1150	2030	7.6	
Evangeline	7	1905	2-26-68	2.0	0.0	452	204	0.6	8.2	16	0.6	500	800	8.6	
	8	456	2-26-68	22	5.1	309	92	1.5	0.4	15	0.0	326	517	7.6	22
	9	219	10-27-49	46	17	288	------67-------		23	49	0.8	389	614	8.1	

1/Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units and temperature degrees centigrade).

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

Municipal

WRPA 9 has 50 sewered communities of 1,000 or more inhabitants. The total population served in 1970 is estimated at 448,800, as shown in table 109. The total daily raw waste production is 80,780 pounds of BOD. According to Programs A and B, the sewered population is expected to be 720,400 and 810,100 by 2020, which are increases of 61 and 81 percent, respectively. Correspondingly, the total raw BOD waste production will increase to 144,080 pounds per day by 2020 for Program A and to 162,020 for Program B.

Of the 50 sewered communities with 1,000 or more inhabitants, there are 28 (56 percent of the WRPA total) that have less than 5,000 inhabitants. The total sewered population of these smaller communities is 74,300 or 17 percent of the total for WRPA 9. The average raw waste production per community is 478 pounds of BOD_5 per day. Eleven communities (22 percent) are in the range of 5,000 to 9,900 inhabitants and have a total sewered population of 81,300 or 18 percent of the WRPA total. The average raw waste production per community is 1,330 pounds of BOD_5 per day. Nine communities (18 percent) are in the range of 10,000 to 49,900 inhabitants and comprise a sewered population of 146,300 or 33 percent of the total for WRPA 9. The average raw waste production per community is 2,926 pounds of BOD_5 per day. Two communities (4 percent) are in the range of 50,000 to 99,000 inhabitants and comprise a sewered population of 146,900 or 33 percent of the total for WRPA 9. The average raw waste production per community is 13,221 pounds of BOD_5 per day.

Many of the sewered communities discharge their effluent to small streams that seasonally have little or no flow. As a consequence, even secondary treatment of sewage may be inadequate and local water quality problems may arise.

Industrial

In 1970 there were 120 industries classified as producing biodegradable wastes in WRPA 9. Major categories involved in this waste production were Food and Kindred products (57 percent of the total number of industries in WRPA 9), Chemical and Allied Products (21 percent), Petroleum and Coal Products (10 percent), Paper and Allied Products (6 percent), Liquid Gas Petroleum Refinery (5 percent) and Lumber and Wood Products (1 percent).

Industrial waste production is comparatively large in WRPA 9. The 120 industries inventoried are located in or near 49 communities, with Lake Charles and Oakdale, Louisiana being the largest centers. In 1970 the combined municipal (domestic and commercial) and industrial loads

Table 109 - Municipal and Industrial Organic Waste Production, WRPA 9

Load Category	Daily Raw Organic Waste Production 1970	Program	1980	2000	2020
Municipal					
P.E. 1/	448,800	A	474,100	573,200	720,400
		B	507,100	650,600	810,100
#BOD 2/	80,780	A	90,080	114,640	144,080
		B	96,350	130,120	162,020
Industrial					
P.E.	2,251,500	A	2,666,300	4,133,800	7,416,600
		B	2,900,900	4,802,500	8,733,700
#BOD	405,280	A	506,600	826,760	1,483,310
			551,180	960,500	1,746,740
Total					
P.E.	2,700,300	A	3,140,400	4,707,000	8,137,000
		B	3,408,000	5,453,100	9,543,800
#BOD	486,060	A	596,680	941,400	1,627,390
		B	647,530	1,090,620	1,908,760

1/ P.E. - Population equivalents: See Methodology.

2/ #BOD - Population of 5-day biochemical oxygen demand.

discharged to the Calcasieu River from Lake Charles and Oakdale, Louisiana were 45,125 and 31,257 pounds of BOD_5 per day, respectively.

As shown in table 109, the population equivalent for 1970 will increase from 2,251,500 to 7,416,600 and 8,733,700 by 2020 according to Programs A and B. These are increases of 229 and 288 percent, respectively. The corresponding raw BOD waste load before treatment of 405,280 pounds per day in 1970 are projected to be 1,483,310 pounds per day by 2020 for Program A and to 1,746,740 for Program B.

Agricultural

WRPA 9 ranks fourth in total organic waste production from livestock and poultry. Among the seven categories of farm animals listed in table 106, cattle and calves is the largest in terms of waste production, accounting for 79 percent of the daily total. Turkeys are the smallest category and totals 0.04 percent of the total waste production.

The total daily raw organic wastes produced by livestock and poultry in WRPA 9 in 1970, and estimated for the projected years, is indicated in table 110. As explained in the Regional Summary, agricultural animal wastes generally constitute non-point sources of pollution and the total waste production must, therefore, not be equated with BOD loads from municipal and industrial sources.

The total daily production of organic wastes from livestock and poultry in 1970 was 681,500 pounds of BOD_5. For Programs A and B this total is expected to increase to 1,478,300 and 1,587,600 pounds by the year 2020.

The land area in WRPA 9 affected by erosion in 1970 totalled about 15 percent and ranged from 4 percent along the Vermilion River to 37 percent in the Calcasieu River Basin. The average gross erosion of the affected areas was 1.9 tons per acre/year and ranged from 1.0 in the Mermentau River Basin to 2.2 tons per acre/year in the Calcasieu River Basin.

The use of fertilizers on extensive tracts of cultivated land is a significant potential source of nutrients that can be carried to the streams by runoff and wind. Little information is available on this loss of fertilizers; however, it would appear that 10 percent may be a realistic low estimate (18). In 1969 the use of fertilizers in WRPA 9 totalled 191,181 tons, which were applied to 1,150,916 acres. This averages 332 pounds of fertilizer per acre per year.

There are no compiled figures on the quantities of agricultural pesticides used in the Lower Mississippi Region. However, insecticides and herbicides are applied by aerial and land spraying or dusting. The loss of significant quantities of pesticides carried to streams by runoff from rainfall or blown by winds is to be expected, possibly on the same order of magnitude (at least 10 percent) as for loss of fertilizers.

Non-Organic Wastes

In addition to the organic waste loads discharged within the Calcasieu River basin, non-BOD waste from industries located at or near Lake Charles, Westlake and Oakdale on the Calcasieu River, and at

Elizabeth on Mill Creek and near DeRidder on Bundick Creek, are cause for concern regarding adverse effects on the quality of these streams. Adequate ambient quality data are not available on these streams. However, the basin is the second largest industrialized area in Louisiana, and includes the manufacturing of chemicals, petrochemicals, and petroleum and paper products. The largest concentration of industry is below the city of Lake Charles. The principal products are petroleum and petrochemicals. A salt-water barrier is located on the Calcasieu River immediately upstream form the city of Lake Charles, and the Lower Calcasieu River is subject to salt water encreachment from the Gulf of Mexico. The industrial discharges of non-BOD wastes are probably not only affecting the quality of Calcasieu Lake but are also being carried into the coastal waters of the Gulf of Mexico. Fourteen industries (16) are in violation of Section 407, River and Harbors Act of 1899. They generally discharge carbonaceous material, suspended solids and oil and grease to the Calcasieu River or to its tributaries. In addition, five of the these industries were in violation for the discharge of heavy metals, thermal wastewaters, nitrogenous materials and complex organics. The fourteen industries, in combination, discharge daily at least 82,000 pounds of chemical oxygen demand, 597,000 pounds of total organic carbon, 601,000 pounds of suspended solids, and 22.4 X 10^{12} calories of heat. Six industries discharge complex organic derivitives of petroleum, some of which are known to be toxic to aquatic life and/or people. Analyses of bottom sediments showed that industrial waste solids are being deposited in the Calcasieu River and in the streams and bayous that are tributary to it.

Table 110 - Organic Waste from Livestock and Poultry, WRPA 9

	1970	Program	1980	2000	2020
BOD_5 1/	681,500	A	833,800	1,111,800	1,478,300
		B	833,800	1,194,400	1,587,600

1/ Pounds of 5-day biochemical oxygen demand.

Bacteria

The disinfection of sanitary wastes for the control of waterborne diseases, as discussed in the Regional Summary, is indicated in table 111 for WRPA 9.

Table 111 - Flows Containing Harmful Bacteria, WRPA 9

	1970	Program	1980	2000	2020
Flow 1/	59.4	A	77.0	106.1	143.5
		B	81.8	120.1	160.9

1/ Millions of gallons of effluent per day.

EXISTING TREATMENT

Municipal and industrial organic waste treatment levels vary widely between communities and between industries. Average municipal sewage treatment for communities located in WRPA 9 are estimated at 50 percent in Louisiana. Total municipal BOD_5 removed by existing treatment in 1970 was 40,440 pounds per day.

Average industrial organic waste treatment is estimated at 55 percent BOD_5 removed throughout the entire region, including WRPA 9. Total industrial BOD_5 removed by existing treatment in 1970 was 222,900 pounds per day.

Agricultural organic wastes are for the most part dispersed over wide areas and generally do not exist as point sources of pollution. Consequently, most wastes are subject to normal practices of land application generally beneficial to soils and crops, but subject to varying degrees of runoff from rainfall and snowmelt.

Disinfection of discharges for disease control are estimated at 75 percent in Louisiana. The total chlorinated discharge in 1970 was 44.5 mgd.

WATER QUALITY CONTROL NEEDS

Water quality control needs exist wherever pollutants are discharged to water supplies. As stated under "Purpose", quantified needs herein are limited to organic or biodegradable wastes, and to bacteria. Organic pollutants are expressed in pounds of BOD_5 per day. Bacterial pollution is expressed in terms of flow in millions of gallons per day requiring treatment.

As explained in "Methodology" municipal and industrial waste loadings are considered point loadings to streams, whereas 95 percent of agricultural loadings are considered non-point sources of pollution. Projected net loadings to streams to the year 2020 are based on calculated total raw waste production minus the quantity of BOD removed or quantity of effluent disinfected by present (1970) treatment held as a constant through the projected 50-year period. Table 112 displays future point source municipal and industrial BOD needs. Table 113 displays point source agricultural BOD needs and table 114 shows needs for control of harmful bacteria.

The unsatisfied or net need shown in the 1970 column of the tables indicates that significant pollution control problems exist in WRPA 9 at the present time. The more notable of these problem areas are displayed on figure 3.

Only five percent of the total agricultural BOD waste production is estimated as entering the surface waters as point sources of pollution. The remaining organic wastes are disposed of by such methods as direct land application, recycling, aerated lagoon-irrigation systems, holding tanks, or some combination of these. Nonetheless, the wastes can cause an ultimate surface water problem unless proper land management practices are instituted and maintained.

Bacterial pollution is probably persistent in stream reaches receiving nondisinfected effluent from population centers. In WRPA 9 the total nondisinfected discharge may increase by 2020 more than sixfold if present levels of disinfection are maintained.

Table 112 - Municipal and Industrial Organic Pollution Control Needs, WRPA 9

Load Category	1970	Program	1980	2000	2020
		(Pounds of BOD_5)			
Municipal					
Total	80,780	A	90,080	114,640	144,080
Exstg. Trmt.	40,440		40,440	40,440	40,440
Net Need	40,340		49,640	74,200	103,640
		B	96,350	130,120	162,020
			40,440	40,440	40,440
			55,910	89,680	121,580
Industrial					
Total	405,280	A	506,600	826,760	1,483,310
Exstg. Trmt.	222,900		222,900	222,900	222,900
Net Need	182,380		283,700	603,860	1,260,410
		B	551,180	960,500	1,746,740
			222,900	222,900	222,900
			328,280	737,600	1,523,840
Total					
Total	486,150	A	596,680	941,400	1,627,390
Exstg. Trmt.	222,810		263,340	263,340	263,340
Net Need			333,340	678,060	1,364,050
		B	647,530	1,090,620	1,908,760
			263,340	263,340	263,340
			384,190	827,280	1,645,420

Table 113 - Agricultural Organic Point Source Loads, WRPA 9

	1970	Program	1980	2000	2020
Waste Load 1/	22,860	A	25,680	33,930	41,410
		B	25,680	36,170	47,340

1/ Pounds of 5-day biochemical oxygen demand per day.

Table 114 - Bacterial Pollution Control Needs, WRPA 9

	1970	Program	1980	2000	2020
Total Discharge 1/	59.4	A	76.9	106.1	143.5
Chlorinated	44.5		44.5	44.5	44.5
Net Need	14.9		32.4	61.6	99.0
		B	81.8	120.0	160.8
			44.5	44.5	44.5
			37.3	75.5	116.3

1/ All figures are millions of gallons of effluent per day.

W R P A 10

STUDY AREA DESCRIPTION

General

In 1970 the New Orleans planning area (WRPA 10) was first in population within the Lower Mississippi Region. According to 1960 economic statistics, WRPA 10 was second in manufacturing and ninth in agricultural employment. It was the region's largest producer of organic wastes from domestic and commercial sources in 1970, comprising 26 sewered communities of 1,000 or more inhabitants with a total population of 998,300 people. The WRPA ranked second in total organic wastewater production from industrial sources with 98 industries classified as producing biodegradable wastes in 1970. These industries generated organic wastes equivalent to those produced in an urban center of approximately 2.9 million people. WRPA 10 was ninth and last in total organic waste production from livestock and poultry. In 1970 this source produced organic wastes equivalent to an urban center of about 0.5 million people.

Water pollution problems in WRPA 10 include: (1) point source discharges organic wastes that exceed the assimilative capacity of the receiving streams, including the Mississippi River, which receives most of the wastewater discharges from WRPA 10, (2) non-organic industrial discharges to the Mississippi River, (3) general bacterial pollution from nondisinfected effluents, and (4) instances of ground water pollution.

Population

WRPA 10 comprises 7,729 square miles in extreme southeastern Louisiana. In 1970 a total of 1,309,000 people inhabited the planning area and by 2020 the population is expected to increase to 2,368,000 and 2,707,000 according the respective projections of Programs A and B (See figure 13).

Of the total 1970 population of 1,309,000, the urban population was 1,086,000, or 83 percent of the total. Table 115 lists the total and urban populations of WRPA 10 for 1970 and the corresponding projected population for 1980, 2000, and 2020 for Programs A and B.

There are 20 communities of 5,000 or more inhabitants. These are listed alphabetically by State in table 116 (see figure 13). New Orleans, Louisiana, is the largest community with 593,471 inhabitants. In addition, there are 22 communities with populations ranging from 1,000 to less than 5,000, and which total 58,400 people.

Table 115 - Population, WRPA 10

Base Population 1970	Programs	Projected Population 1980	2000	2020
Total Population				
	A	1,478,000	1,864,000	2,368,000
1,309,000	B	1,595,000	2,079,000	2,707,000
Urban Population				
	A	1,227,000	1,566,000	2,013,000
1,086,000	B	1,324,000	1,746,000	2,301,000

Table 116 - Principal Communities, WRPA 10

Community 1/	Parish	State	Community Population 1970
Donaldsonville	Ascension	Louisiana	7,367
Marrero	Jefferson	"	29,015
Harvey	Jefferson	"	6,347
Little Farms	Jefferson	"	15,713
Kenner	Jefferson	"	29,858
Jefferson Hgts.	Jefferson	"	16,489
Terry	Jefferson	"	13,832
Gretna	Jefferson	"	24,875
Metairie	Jefferson	"	135,816
Harahan	Jefferson	"	13,037
Westwego	Jefferson	"	11,402
Thibodaux	Lafourche	"	14,925
New Orleans	Orleans	"	593,471
Reserve	St. John the Baptist	"	6,381
Laplace	St. John the Baptist	"	5,953
Morgan City	St. Mary	"	16,586
Covington	St. Tammany	"	7,170
Sidell	St. Tammany	"	16,101
Bayou Cane	Terrebonne	"	9,077
Houma	Terrebonne	"	30,922
Twenty communities with a total population of :			1,004,337

1/ Incorporated places (cities, villages, towns, or boroughs) of 5,000 or more inhabitants.

LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WATER RESOURCE PLANNING
AREA 10

FIGURE 13

Economy

Total employment in WRPA 10 in 1968 was 460,494. This is an increase of 21.9 percent over 1959. By 2020 the total employment, according to Programs A and B projections, is expected to increase to 918,000 and 1,083,000 respectively. As compared to the other planning areas in the Lower Mississippi Region, WRPA 10 was second in total employment in 1968.

One hundred eighty-six industries that yield wastewaters in relatively large quantities and high BOD concentrations are located in WRPA 10. Food, paper, chemicals and petroleum products industries comprise about 97 percent of the organic waste producing industries in the planning area. Among these four major industrial groups, food and kindred products and chemical and allied products industries comprise about 61 and 20 percent, respectively.

Table 117 indicates the growth of employment and of industrial water use for Programs A and B to the year 2020. The water use indexes are an average of the employment and earnings.

Mining operations include fuels and nonmetallic minerals. Natural gas and petroleum are the principal fuels mined. The 1969 production figure for natural gas was 2,961,152 million cubic feet, while petroleum was 792,232 thousand barrels. Among the nonmetallic minerals sand and gravel ranks first in production at 3,781,000 short tons mined in 1969.

Agricultural production reports of livestock and poultry place cattle and calves and hogs and pigs among the most numerous of large farm animals. In 1970 there were 73,500 cattle and calves and 13,400 hogs and pigs, ranking WRPA 10 ninth in the Lower Mississippi Region with respect to production of cattle and calves and ninth in production of hogs and pigs. Table 118 indicates the projected increase in production to the year 2020 for Programs A and B.

Selected Streams

The Tchefuncta River, Gulf Intercoastal Waterway, Bayou Chauvin, Lake Pontchartrain, Mayrone Canal, Lockport Canal, Bayou Lafourche and Black Bayou receive the largest discharges of organic wastes in WRPA 10. Discharges to the Mississippi River are discussed in WRPA 1. Streamflow is sustained by ground water seepage and by runoff from rainfall. Exceptions to this are the Mississippi River which receives vast quantities of snowmelt, particularly in its upper reaches, and Bayou Lafourche which receives its entire flow from diversion water pumped from the Mississippi River at Donaldsonville.

Table 117 - Employment, WRPA 10

Program	Year	Major Industry Employment	Major Industry Earnings 1/	Indexes Employment	Indexes Earnings	Indexes Water Use
A	1968	460,500	3,125	100	100	100
	1980	538,000	5,069	117	162	140
	2000	701,000	11,014	152	352	252
	2020	918,000	23,949	199	766	483
B	1968	460,500	3,125	100	100	100
	1980	590,000	5,557	128	178	153
	2000	811,000	12,738	176	408	292
	2020	1,083,000	28,247	235	904	570

1/ In millions of dollars. Industrial water use indexes are an average of employment and earnings indexes.

Table 118 - Numbers of Livestock and Poultry, WRPA 10

Livestock and Poultry	1970	Program	1980	2000	2020
Cattle and Calves	73,500	A	93,700	126,100	169,300
		B	93,700	135,400	181,800
Milk Cows	4,500	A	4,200	5,100	6,300
		B	4,200	5,500	6,700
Hogs and Pigs	13,400	A	15,300	19,900	25,900
		B	15,300	21,400	27,800
Sheep and Lambs	3,900	A	3,000	3,500	4,300
		B	3,000	3,800	4,700
Chickens	331,100	A	363,700	465,600	589,800
		B	363,700	500,200	633,400
Broilers	0	A	0	0	0
		B	0	0	0
Turkeys	800	A	1,100	1,500	2,000
		B	1,100	1,600	2,200

The waste assimilative capacities of these streams are least during periods of lowest streamflow, which generally occur in the months of August, September or October.

Appendix C contains a streamflow summary for selected sites in WRPA 10. Streamflow characteristics are affected by flow regulation and withdrawals for water supply. Flow data are sparse.

The Tchefuncta River near Folsom is recorded as having maximum and minimum momentary flows of 29,200 and 26 cfs, respectively. The corresponding figures for Bayou LaFourche at Donaldsonville are 542 and 0, respectively. Mean flows at the same gaging stations on the Tchefuncta River and Bayou LaFourche are 153 and 273 cfs, respectively. Zero flow is assumed to occur on numerous small streams throughout the planning area.

Surface water is withdrawn for industry, electric power production, and preservation of fish and wildlife. There are no reservoirs in WRPA 10 that have a capacity of 5,000 acre-feet or more.

Major Aquifers

Ground water supplies are obtained from aquifers that comprise rock units of Quaternary and Tertiary age. The aquifer that yields the major quantity of water for municipal, industrial, and agricultural use is the Pleistocene aquifer in the Quaternary Alluvium.

The water quality of these aquifers is discussed in the next section of this appendix. A listing of aquifers in WRPA 10 is presented as part of table 120 of that section. For details regarding the geology of the aquifers, see Appendix C.

PRESENT STATUS

Water Use

Water use for municipal supply, industry, and irrigation totalled 2227.9 mgd in 1970. Municipal supply accounted for 184.7 mgd (813 percent), industrial use for 2038.8 mgd (91.5 percent) and irrigation for 4.4 mgd (0.2 percent) of this total. As compared to the other planning areas, in 1970 WRPA 10 was first in total water use. By 2020 it is expected that water use for Program A (and Program B will increase by 132 percent (163 percent) for municipal supply by 804 percent (966 percent) for industry and 95 percent (416 percent) for irrigation.

Cooling water used for thermal electric power generation totalled 1406.4 mgd in 1970, and this constituted the third largest water demand in WRPA 10. As compared to the other planning areas, WRPA 10 ranked first in total thermal electric cooling water requirements. By 2020 it is expected that this water use will increase 343 percent for Program A and 403 percent for Program B.

Water Quality

Surface Water

In WRPA 10 water analyses are available on Bayou Lafourche, Bayou Terrebonne, Old Intracoastal Waterway, and Gulf Intracoastal Waterway. Selected analyses of water are listed for these major streams in table 119.

The analyses listed in this table indicate that Bayou LaFourche is a calcium bicarbonate type water from its upper reaches to near Lockport, Louisiana. At Valentine; Louisiana, and downstream, the water quality varies depending on salt water tidal effects, which cause shifts to high sodium chloride concentrations. Bayou Terrebonne at Houma, Louisiana, shifts from a calcium bicarbonate water to a sodium bicarbonate water. The Old Intracoastal Waterway and the Gulf Intracoastal Waterway are principally sodium chloride waters. These streams and watercourses have maximum dissolved solids, sulfate and chloride concentrations of 1,060, 73 and 500 mg/1, respectively. As indicated in table 127, the recommended limiting concentrations of dissolved solids, sulfate and chloride for drinking water are 500, 250 and 250 mg/1, respectively.

Ground Water

In WRPA 10 analyses of ground water are available from aquifers of Quaternary and Tertiary age. The analyses listed in table 120 include one well in the Quaternary alluvium and three wells in the Tertiary aquifers.

Table 119 - Stream Quality, WRPA 10 1/

Stream Sampling Station	Date of Collection	Mean Discharge (cfs)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids (mg/1)	Specific Conductance (micromhos)	pH	Dissolved Oxygen (mg/1)	Temp. °C
Bayou Lafourche at Donaldsonville, Louisiana	1-19-59 2-27-59	266 208	49 33	13 7.5	147 98	26 10	2.5 2.7	61 32	33 16	2.9 3.4	278 192	440 280	8.0 7.4		
Bayou Lafourche at Thibodaux, Louisiana	1-16-59 7-28-59		55 30	13 7.1	235 109	20 10	3.0 3.4	34 21	4.0 12	0.1 1.6	458 161	458 258	7.0 7.0		
Bayou Lafourche at Thibodaux, Louisiana	8-3-56 3-21-56		42 36	11 8.3	138 115	----24---- 9.9	 3.3	52 32	23 14	2.0 1.7	229 170	389 299	7.2 7.1		
Bayou Lafourche at Lockport, Louisiana	3-21-56		36	8.4	117	9.3	3.2	32	14	0.6	170	297	7.3		
Bayou Lafourche at Valentine, Louisiana	9-23-59 2-27-59		39 22	30 4.4	85 75	285 6.2	12 3.5	73 11	500 11	0.4 2.4	1,060 108	1,950 182	7.0 6.9		
Bayou Lafourche at Cut-Off, Louisiana	6-23-60 10-27-59		41 25	19 8.4	132 89	110 56	6.6 3.1	46 19	196 46	0.2 1.2	538 276	929 481	6.7 7.3		
Bayou Terrebonne at Houma, Louisiana	1-16-59 10-28-58		38 30	31 5.9	268 115	28 11	8.3 3.4	6.0 6.4	47 13	0.5 1.8	372 140	573 239	7.4 6.7		
Old Intracoastal Waterway at Lockport, Louisiana	4-14-56 8-4-56		40 26	16 8.7	119 92	-----85---------- -----45----------		46 24	145 68	1.8 3.5	398 229	751 419	6.9 7.2		
Old Intracoastal Waterway near Bourg, Louisiana	8-4-56 3-21-56		30 29	8.8 8.6	101 97	-----53---------- 38	 4.2	33 17	76 70	2.0 1.3	260 224	459 419	7.7 7.3		
Gulf Intracoastal Waterway, at Houma, Louisiana	8-19-60 10-27-59		31 25	9.9 8.4	95 88	75 53	3.4 2.5	31 21	126 85	0.5 1.0	365 254	615 463	6.7 7.2		
Old Intracoastal Waterway at Gayoso, Louisiana	4-25-56 3-21-56		42 36	14 11	135 122	-----36---------- 20	 3.7	27 38	67 29	8.2 0.6	269 206	501 378	6.6 7.3		

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

Table 120 - Ground-Water Quality, WRPA 10 [1/]

Aquifer System	Well No.	Well Depth (ft.)	Date of Collection	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Specific Conductance	pH	Temperature (°C)
Quaternary Alluvium	1	375	5-10-68	24	11	508	347	3.5	0.2	308	3.2	971	1740	8.0	21
Pliocene	2	1390	7-26-68	0.0	0.0	144	59	0.2	8.6	3.5	0.1	182	245	8.0	
Miocene	3	2400	7-25-68	1.6	0.0	238	97	0.6	13	4.7	0.0	256	399	8.2	
	4	1998	8-2-63	1.9	0.1	148	60	1.1	9.4	3.8	0.3	136	264	8.2	

1/ Concentrations expressed in milligrams per liter except specific conductance (micromhos at 25°C), pH (units) and temperature (degrees centigrade).

The tertiary aquifers yield water meeting the recommended limiting concentrations for drinking purposes and which is of the sodium bicarbonate type. As indicated in table 120, the Quaternary alluvium yields water exceeding the recommended limiting concentrations for drinking water. The concentrations of dissolved solids, chlorides and sulfates in water from this well were 971,308 and 0.2 respectively. The alluvium may be expected to yield highly mineralized water over much of WRPA 10.

The recent U. S. Geological Survey study of ground water pollution (4) discusses one occurrence in WRPA 10. The pollutant is salt water.

In the New Orleans area from 100 to 150 wells have been abandoned for 40 years or more. Brackish water can leak through these into the "700-foot" sand. The damage from this situation is minimal due to the fortuitous location of the wells.

The proposed diversions of water from the Mississippi River to distant basins may adversely affect areas in the coastal zones by causing a landward shift of saline Gulf waters. This would result in changes in aquatic life in the coastal swamps and estuaries and in loss of potable ground water reserves where saline surface water spread out over fresh water aquifers.

Appendix C shows the altitude of the base of fresh water in the Coastal Plain aquifers of the region. In WRPA 10 the base of fresh water ranges extensively from less than 500 feet below mean sea level to locally more than 3,500 feet below mean sea level in St. Tammany Parish, Louisiana.

PRESENT AND PROJECTED WASTE PRODUCTION

Organic Wastes

Municipal

WRPA 10 has 26 sewered communities of 1,000 or more inhabitants. The total population served in 1970 is estimated at 998,300, as shown in table 121. The total daily raw waste production is 179,690 pounds of BOD. According to Programs A and B, the sewered population is expected to be 1,937,200 and 2,168,100 by 2020, which are increases of 94 and 117 percent, respectively. Correspondingly, the total raw BOD waste production will increase to 396,840 pounds per day by 2020 for Program A and to 443,880 for Program B.

Of the 26 sewered communities of 1,000 or more inhabitants, there are 9 (35 percent of WRPA total) that have less than 5,000 inhabitants. The total sewered population of these smaller communities is 27,000 or 3 percent of the total for WRPA 10. The average raw waste production per community is 540 pounds of BOD_5 per day. Four communities (26 percent) are in the range of 5,000 to 9,900 inhabitants and have a total sewered population of 25,900 or 3 percent of the WRPA total. The average raw waste production per community is 1,166 pounds of BOD_5 per day. Eleven communities (42 percent) are in the range of 10,000 to 49,900 inhabitants and comprise a sewered population of 216,100 or 22 percent of the total for WRPA 10. The average raw waste production per community is 3,536 pounds of BOD_5 per day. There are no communities in the 50,000 to 99,900 population range but there are 2 communities with populations exceeding 100,000. They comprise a sewered population of 729,300 or 72 percent of the total for WRPA 10. The average raw waste production per community is 65,637 pounds of BOD_5 per day.

Many of the sewered communities discharge their effluent to small streams that seasonally have little or no flow. As a consequence, even secondary treatment of sewage may be inadequate and local water quality problems may arise.

Industrial

In 1970 there were 186 industries classified as producing biodegradable wastes in WRPA 10. Major categories involved in this waste production were Food and Kindred Products (61 percent of the total number of industries in WRPA 10), Chemical and Allied Products (20 percent), Paper and Allied Products (11 percent), Petroleum and Coal Products (5 percent), Liquid Gas Petroleum Refinging (1 percent), and others (2 percent).

Industrial waste production is large in WRPA 10. The 186 industries inventoried are located in or near 28 communities, with Greater New Orleans and Thibodaux, Louisiana being the largest centers. In 1970 the combined municipal (domestic and commercial) and industrial loads discharged to the Mississippi River and to Lake Pontchartrain totalled 210,141 pounds of BOD_5 per day from Greater New Orleans Industrial

District. The combined municipal and industrial loads discharged to Black Bayou from Thibodaux, Louisiana totalled 12,879 pounds of BOD_5 per day. Food processing companies produced the largest quantities of organic wastes in both cities.

As shown in table 121, the population equivalent for 1970 will increase from 2,921,100 to 12,697,900 and 14,985,100 by 2020 according to Programs A and B. These are increases of 335 and 413 percent, respectively. The corresponding raw BOD waste load before treatment of 525,790 pounds per day in 1970 are projected to be 2,539,580 pounds per day by 2020 for Program A and 2,997,010 for Program B.

Agricultural

Among the seven categories of farm animals listed in table 118, cattle and calves is the largest in terms of waste production, accounting for 80 percent of the daily total. Turkeys is the smallest category and totals 0.1 percent of the total waste production.

The total daily raw organic wastes produced by livestock and poultry in WRPA 10 in 1970, and estimated for the projected years, is indicated in table 122. As explained in the Regional Summary, agricultural animal wastes generally constitute non-point sources of pollution and the total waste production must, therefore, not be equated with BOD loads from municipal and industrial sources.

The total daily production of organic wastes from livestock and poultry in 1970 was 91,600 pounds of BOD_5. For Programs A and B this total is expected to increase to 199,700 and 214,300 pounds by the year 2020.

The land area in WRPA 10 affected by erosion in 1970 totalled about 3.7 percent and ranged from 0.3 percent along the Mississippi River to 23.5 percent in the Amite River Basin. The average gross erosion of the affected areas was 6.6 tons per acre/year and ranged from 0.3 along the Mississippi to 7.3 tons per acre/year in the Amite River Basin.

The use of fertilizers on extensive tracts of cultivated land is a significant potential source of nutrients that can be carried to the streams by runoff and wind. Little information is available on this loss of fertilizers; however, it would appear that 10 percent may be a realistic low estimate (18). In 1969 the use of fertilizers in WRPA 10 totalled 20,030 tons, which were applied to 143,072 acres. This averages 280 pounds of fertilizer per acre per year.

There are no figures on the quantities of agricultural pesticides used in the Lower Mississippi River. However, insecticides and herbicides would be used and applied by aerial and land spraying or dusting. The loss of significant quantities of pesticides carried to streams by runoff from rainfall or blown by winds is to be expected, possibly on the same order of magnitude (at least 10 percent) as for loss of fertilizers.

Table 121 - Municipal and Industrial Organic Waste Production, WRPA 10

Load Category	Daily Raw Organic Waste Production				
	1970	Program	1980	2000	2020
Municipal					
P. E. 1/	998,300	A	1,139,200	1,475,400	1,937,200
		B	1,228,900	1,645,500	2,168,100
#BOD 2/	184,170	A	221,770	302,200	396,840
		B	239,250	377,100	443.880
Industrial					
P. E.	2,921,100	A	3,874,300	6,625,000	12,697,900
		B	4,234,000	7,676,600	14,985,100
#BOD	525,790	A	736,110	1,325,000	2,539,580
		B	804,460	1,535,310	2,997,010
Total					
P. E.	3,919,400	A	5,013,500	8,100,400	14,635,100
		B	5,462,900	9,322,100	17,153,200
#BOD	709,960	A	957,880	1,627,200	2,936,420
		B	1,043,710	1,912,410	3,440,890

1/ P.E. - Population equivalent: See Methodology.
2/ #BOD - Pounds of 5-day biochemical oxygen demand.

Table 122 - Organic Wastes from Livestock and Poultry, WRPA 10

	1970	Program	1980	2000	2020
BOD_5 1/	91,600	A	112,500	150,100	199,700
		B	112,500	161,200	214,300

1/ Pounds of 5-day biochemical oxygen demand.

Non-Organic Wastes

In WRPA 10 non-BOD waste waters from industrial sources are discharged in large quantities to the Mississippi River and are discussed in WRPA 1. Many industries have initiated abatement programs as required by the State of Louisiana and by the Refuse Act Program of the Environmental Protection Agency.

Bacteria

The disinfection of sanitary wastes for the control of waterborne diseases, as discussed in the Regional Summary, is indicated in table 123 for WRPA 10.

Table 123 - Flows Containing Harmful Bacteria, WRPA 10

	1970	Program	1980	2000	2020
Flows 1/	179.6	A	208.8	272.7	350.0
		B	225.5	304.1	396.1

1/ Millions of gallons of effluent per day.

EXISTING TREATMENT

Municipal and industrial organic waste treatment levels vary widely between communities and between industries. Average municipal sewage treatment for communities located in WRPA 10 are estimated at 50 percent in Louisiana. Total municipal BOD_5 removed by existing treatment in 1970 was 92,090 pounds per day.

Average industrial organic waste treatment is estimated at 55 percent BOD_5 removed throughout the entire region, including WRPA 10. Total industrial BOD_5 removed by existing treatment in 1970 was 289,180 pounds per day.

Agricultural organic wastes are for the most part dispersed over wide areas and generally do not exist as point sources of pollution. Consequently, most wastes are subject to normal practices of land application generally beneficial to soils and crops, but subject to varying degrees of runoff from rainfall and snowmelt.

Disinfection of discharges for disease control are estimated at 75 percent in Louisiana. The total chlorinated discharge in 1970 was 134.7 mgd.

WATER QUALITY CONTROL NEEDS

Water quality control needs exist wherever pollutants are discharged to water supplies. As stated under "Purpose," quantified needs herein are limited to organic or biodegradable wastes, and to bacteria. Organic pollutants are expressed in pounds of BOD_5 per day. Bacterial pollution is expressed in terms of flow in millions of gallons per day requiring treatment.

As explained in "Methodology" municipal and industrial waste loadings are considered point loadings to streams, whereas 95 percent of agricultural loadings are considered non-point sources of pollution. Projected net loadings to streams to the year 2020 are based on calculated total raw waste production minus the quantity of BOD removed or quantity of effluent disinfected by present (1970) treatment held as a constant through the projected 50-year period. Table 124 displays future point source municipal and industrial BOD needs. Table 125 displays point source agricultural BOD needs and table 126 shows needs for control of harmful bacteria.

The unsatisfied or net need shown in the 1970 column of the tables indicates that significant pollution control problems exist in WRPA 10 at the present time. The more notable of these problem areas are displayed on figure 3.

Only five percent of the total agricultural BOD waste production is estimated as entering the surface waters as point sources of pollution. The remaining organic wastes are disposed of by such methods as direct land application, recycling, aerated lagoon-irrigation systems, holding tanks, or some combination of these. Nonetheless, the wastes can cause an ultimate surface water problem unless proper land management practices are instituted and maintained.

Bacterial pollution is probably persistent in stream reaches receiving nondisinfected effluent from population centers. In WRPA 10 the total nondisinfected discharge may increase by 2020 about fivefold if present levels of disinfection are maintained.

Table 124 - Municipal and Industrial Organic Pollution Control Needs, WRPA 10

Load Category	1970	Program	1980	2000	2020
			(Pounds of BOD_5)		
Municipal 1/					
Total	184,170	A	221,770	302,200	396,840
Exstg. Trmt.	92,090		92,090	92,090	92,090
Net Need	92,080		129,680	210,110	304,750
		B	239,250	377,100	443,880
			92,090	92,090	92,090
			147,160	285,010	351,790
Industrial					
Total	525,790	A	736,110	1,325,000	2,539,580
Exstg. Trmt.	289,180		289,180	289,180	289,180
Net Need	236,610		446,930	1,035,820	2,250,400
		B	804,460	1,535,310	2,997,010
			289,180	289,180	289,180
			515,280	1,246,130	2,707,830
Total					
Total	709,960	A	957,880	1,627,200	2,936,420
Exstg. Trmt.	381,270		381,270	381,270	381,270
Net Need	328,690		576,610	1,245,930	2,555,150
		B	1,043,710	1,912,410	3,440,890
			381,270	381,270	381,270
			662,440	1,531,140	3,059,620

1/ Includes Gretna, La. (presently unsewered).

Table 125 - Agricultural Organic Point Source Loads, WRPA 10

	1970	Program	1980	2000	2020
Waste Load 1/	2,850	A	3,240	4,220	5,490
		B	3,240	4,810	5,890

1/ Pounds of 5-day biochemical oxygen demand per day.

Table 126 - Bacterial Pollution Control Needs, WRPA 10

	1970	Program	1980	2000	2020
Total Discharge 1/	179.6	A	208.8	272.7	350.0
Chlorinated	134.7		134.7	134.7	134.7
Net Need	44.9		74.1	138.0	215.3
		B	225.4	304.1	396.1
			134.7	134.7	134.7
			90.7	169.4	261.4

1/ All figures are millions of gallons of effluent per day.

M E T H O D O L O G Y

ORGANIC WASTE LOADS

Municipal

Municipal (domestic and commercial) organic waste loads are comprised principally of human biological wastes and ground-up kitchen refuse from domestic households and from hotels, motels, restaurants, hospitals, office buildings, and other commercial buildings. Industrial organic waste discharges to municipal systems are included under industrial wastes.

The base population used to estimate the municipal waste loads consists of the sum of all sewered communities with a 1970 population of 1,000 or more. Present (1970) population of these communities was obtained from the U.S. Department of Commerce, Bureau of Census. A listing of sewered communities was obtained from the 1968 inventory "Municipal Waste Facilities" prepared by the Environmental Protection Agency and from other available inventories within EPA. Future population projections for sewered communities were made within the general constraining conditions contained in Appendix B, Economics; Appendix F, Land Resources; and past County trends for the period 1950 to 1970. The population equivalent (P.E.) listed for municipal loadings throughout the appendix is equal to the estimated population served.

Unit weights of BOD_5 per person were applied to the population served to obtain the municipal waste production.

The present (1970) organic waste load per capita in the Lower Mississippi Region was assumed to be 0.18 pounds BOD_5.

Increasing affluence within the Lower Mississippi Region will result in future organic waste loads per capita as follows:

1980 - 0.19 pounds BOD_5 per capita per day.

2000 and thereafter - 0.20 pounds BOD_5 per capita per day.

Existing average municipal waste treatment levels, as shown in table 13, were estimated for that portion of each State lying within the study area using "1968 Inventory, Municipal Waste Facilities" and expert knowledge of the situation in each State, with allowance made for existing sewage treatment plant efficiencies. These average levels were then applied uniformly to the total waste production for each respective area to determine wastes removed by existing (1970) treatment.

The existing treatment was held constant through time and deducted from the total wastes produced to arrive at net needs.

Industrial

Industrial organic waste production was developed principally by applying an average BOD_5 waste load per unit of discharge for each of the inventoried organic waste-producing industries in the region. These industry categories, by Standard Industrial Classification, are listed below:

SIC 20 - Food and Kindred Products
SIC 22 - Textile Mill Products
SIC 24 - Lumber and Wood Products, except furniture
SIC 26 - Paper and allied products
SIC 28 - Chemicals and allied products
SIC 29 - Petroleum refining and related industries

The industries presently located in the study area were identified from State Industrial Listings supplemented by other available data.

The discharges of specific industries, where not known, were estimated by application of a unit discharge per employee arrived at by averaging employment and earnings indexes. Employment data were obtained from the same sources used for industry identification, above.

Once the base discharges were determined, a unit load of BOD_5 per unit of discharge for each industry type was applied. These unit loadings were obtained from "Industrial Water Use" by Willis G. Eichberger and from other publications of the U.S. Department of Health, Education and Welfare (Public Health Service) and from publications of the Environmental Protection Agency. This operation yielded base (1970) industrial waste production in the region by industry type.

Projected future loads were derived by application of growth indexes to the base waste production. The indexes of growth are an average of projected employment and industrial output. It was necessary to introduce industrial productivity to compensate for projected increases in employee productivity because employment, used alone, would tend to provide an underestimate of both the discharge of an industry and the related waste production.

The average 1970 treatment level of industrial organic wastes in the region was estimated to be 55 percent BOD_5 removal. This level was applied uniformly throughout the region to the total organic wastes produced to determine wastes removed by existing treatment. The waste removed by existing treatment was held constant through time and deducted from the total waste production to arrive at net needs.

Agricultural

Estimates of organic wastes from livestock and poultry were calculated from conservative published data on the contributions of BOD wastes for farm animals in the seven categories listed below. One animal in each category produces a 5-day BOD corresponding to that produced by the number of people indicated.

Animal Category	Population Equivalent
Cattle and calves	5.9
Milk Cows	7.7
Hogs and Pigs	1.6
Sheep and Lambs	0.57
Chickens	0.14
Broilers	0.14
Turkeys	0.35

The number of farm animals in the base year 1970 and for the projected years to 2020 were obtained from Appendix H. To calculate the total daily waste production from farm animals, the numbers of animals in each category were multiplied by the corresponding population equivalents listed above. However, the total number of farm animals for a given year is not necessarily the total for any given day of that year. This applies both to human populations as well as animals, and normally this poses no particular problem in determining daily total waste production because there is generally no complete turnover of many generations in a year's period involving very large numbers of animals. The exception to this is broilers.

Broilers reach marketing age at about 10 weeks and four hatches are produced annually. Therefore, of the 89,530,600 and 251,371,400 broilers listed in table 3 for 1970 and 2020 (Program B), respectively, only one-fourth are in existence during any given day. Consequently, the daily waste production from broilers is based, for example, on 22,383,650 and 62,842,850 for 1970 and 2020 (Program B), respectively.

The total waste production from livestock and poultry was calculated by applying population equivalents to present and projected numbers of animals in the Lower Mississippi Region. The #0.18/day of BOD_5 constant was then applied to the total population equivalents to arrive at waste produced in the agricultural sector.

The calculated waste production is the product of the unit population equivalent times the number of farm animals in each category times #0.18 BOD_5. The waste load produced by broilers is estimated as 25 percent of the number obtained by this method; however, due to the fact that only about one-fourth of the total annual inventory of this animal may be considered as being constantly on-farm.

The portion of the total waste production that enters the streams as point-source loads was based on estimates made of that portion of each animal category which is confined and of the wastes produced in confinement which enter the water courses in the region. These estimates and corresponding percentages of total load produced which are point loads are as follows:

Category	Percent of Animals Confined	Percent of Confined Wastes - Point Load	Percent of Total Wastes - Point Load
Cattle and Calves	5	25	1.3
Milk Cows	35	25	8.8
Hogs and Pigs	50	40	20.0
Sheep and Lambs	0	0	0
Chickens) Broilers) Turkeys)	90	9	8.1

These approximations were applied uniformly throughout the region to obtain point-load estimates from livestock and poultry.

BACTERIA

The gross quantity of waste water requiring treatment for bacteria control in 1970 and 2020 was based on total human population served and on the estimated per capita water use for each WRPA. Estimated levels of chlorination, based on observed levels of chlorination at some sites within the region and the judgment of expert personnel within the Environmental Protection Agency, were used to calculate the total water treated in 1970. The total net need for chlorination (expressed in million of gallons per day) equals the 1970 and 2020 discharges minus the total quantity of chlorinated effluent for 1970 held as a constant to 2020. The gross quantities requiring treatment in 1980 and 2000 were determined by interpolation from the figures for 1970 and 2020.

WATER QUALITY CRITERIA

Water quality criteria are defined as permissible and desirable. Permissible criteria include those characteristics and concentrations of substances in raw surface waters which will allow the production of a safe, clear, potable, aesthetically pleasing, and acceptable public water supply which meets the limits of Drinking Water Standards after treatment. This treatment may include coagulation, sedimentation, rapid sand filtration, and chlorination. Desirable criteria include those characteristics and concentrations of substances in raw surface waters which represent high-quality water in all respects for use as public water supplies. Water meeting these criteria can be treated with greater factors of safety or at less cost than is possible with waters meeting permissible criteria.

Table 127 presents water criteria for public water supplies. A discussion of each parameter is developed in the paragraphs that follow.

ODOR

The effectiveness of the defined method of treatment in removing odorous materials from water is highly variable depending on the nature of the material causing the odor. For this reason, it has not been feasible to specify any permissible criterion in terms of threshold odor number. The raw water should not have objectionable odor. Any odor present should be removable by the defined treatment. It is desirable that odor be virtually absent.

TEMPERATURE

Surface water temperatures vary with geographical location and climatic conditions. Consequently, no fixed criteria are feasible. However, any of the following conditions are considered to detract (sometimes seriously) from raw water quality for public water supply use:

1. Water temperature higher than 85° F.;

2. More than 5° F. water temperature increase in excess of that caused by ambient conditions.

3. More than 1° F. hourly temperature variation over that caused by ambient conditions;

Table 127 - Water Criteria for Public Water Supplies

Constituent or Characteristic	Permissible Criteria	Desirable Criteria
Physical		
Odor	Narrative	Virtually absent
Temperature 1/	Narrative	Narrative
Microbiological		
Coliform organisms	10,000/100 ml 2/	<100/100 ml 2/
Fecal coliforms	2,000/100 ml 2/	<20/100 ml 2/
Inorganic Chemicals		
Alkalinity	Narrative	Narrative
Chloride	250	<25
Dissolved oxygen	≥4 (monthly mean) ≥3 (individual sample)	Near saturation
Nitrates plus nitrites	10 (as N)	Virtually absent
pH (range)	6.0-8.5	Narrative
Phosphorus	Narrative	Narrative
Sulfate	250	<50
Total dissolved solids	500	<200

1/ The defined treatment process has little effect on this constituent.
2/ Microbiological limits are monthly arithmetic averages based upon an adequate number of samples. Total coliform limit may be relaxed if fecal coliform concentration does not exceed the specified limit.

4. Any water temperature change which adversely affects the biota, taste, and odor, or the chemistry of the water;

5. Any water temperature variation or change which adversely affects water treatment plant operation (for example, speed of chemical reactions, sedimentation basin hydraulics, filter wash water requirements, etc.);

6. Any water temperature change that decreases the acceptance of the water for cooling and drinking purposes.

COLIFORM AND FECAL ORGANISMS

Bacteria have been used as indicators of sanitary quality of water since 1880 when E. coli and similar organisms were shown to be normal inhabitants of fecal discharges. The coliform group as presently recognized by Drinking Water Standards is defined in Standard Methods for the Examination of Water and Wastewater. This group includes organisms that vary in biochemical and serological characteristics and in their natural sources and habitats; i.e., feces, soil, water, vegetation, etc.

Because the sanitary significance of the various members of the coliform group derives from their natural sources, differentiation of fecal from non-fecal organisms is important to evaluate raw water quality. Fecal coliforms are characteristically inhabitants of warm-blooded animal intestines. Members of other coliform subgroups may be found in soil, on plants and insects, in old sewage, and in waters polluted some time in the past.

The objective of using the coliform group as an indicator of the sanitary quality of water is to evaluate the disease-producing potential of the water. To estimate the probability of pathogens being contributed from feces, the coliform and fecal coliform content must be quantified.

In relation to raw water sources, the following suggestions are offered to help resolve some of the difficulties of data interpretation.

Fecal coliform organisms may be considered indicators of recent fecal pollution. It is necessary to consider all fecal coliform organisms as indicative of dangerous contamination. Moreover, no satisfactory method is currently available for differentiating between fecal organisms of human and animal origin.

In the absence of fecal coliform organisms, the presence of other coliform group organisms may be the result of less recent fecal pollution, soil run-off water, or, infrequently, fecal pollution containing only those organisms.

In general, the presence of fecal coliform organisms indicates recent and possible dangerous pollution. The presence of other coliform organisms suggests less recent pollution or contributions from other sources of non-fecal origin.

In the past the coliform test has been the principal criterion of suitability of raw water sources for public water supply. The increase in chlorination of sewage treatment plant effluents distorts the criterion by reducing coliform concentrations without removing many other substances which the defined water treatment plant is not well equipped to remove. It is essential that raw water sources be judged as to suitability by other measures and criteria than coliform organism concentrations.

The defined water treatment plant is considered capable of producing water meeting Drinking Water Standards bacteriological criteria. The difference between the suggested concentration of 10,000 coliforms per 100 ml and the former figure of 5,000 per 100 ml is justified by the difference between the Phelps Index and the MPN. It has been suggested that these numbers and the additional consideration of fecal coliforms be applied in order to provide more realistic parameters in full recognition of modern knowledge and not as a means of sanctioning increased bacterial pollution of water destined for public water supply use.

ALKALINITY

Alkalinity in water should be sufficient to enable floc formation during coagulation, must not be high enough to cause physiological distress in humans, and must be proper for a chemically balanced water (neither corrosive nor incrusting). A criterion for minimum and maximum alkalinity in public water supply is related to the relative amounts of bicarbonates, carbonates, and hydroxide ions causing the alkalinity; and also to the pH, filterable (dissolved) solids, and calcium content. Because the permissible criterion for filterable solids is 500 mg/l and the pH range is 6.0 to 8.5, alkalinity should not be less than about 30 mg/l.

The criterion for maximum alkalinity cannot be expressed in calcium carbonate equivalents as determined from 0.02n H_2SO_4 titration because of the interrelationships stated above. However, alkalinity values higher than about 400 mg/l to 500 mg/l would be too high for public water supply use. Within the range of 30 mg/l to 500 mg/l, the alkalinity criterion should be that value which is normal to the natural water and which from experience is satisfactory for public water supply use. Frequent variations from normal values are detrimental to public water supply processing control.

CHLORIDES AND SULFATES

The significance of these substances as contaminants of drinking water is discussed in Drinking Water Standards. The permissible criteria in this report are those included in Drinking Water Standards. The defined treatment plant does little or nothing to remove these substances.

DISSOLVED OXYGEN

Criteria for dissolved oxygen are included, not because the substance is of appreciable significance in water treatment or in finished water, but because of its use as an indicator of pollution by organic wastes. It is intended for application to free-flowing streams and not to lakes or reservoirs in which supplies may be taken from below the thermocline.

NITRATE AND NITRITE

A limit of 10 mg/l (as elemental nitrogen) of nitrate ion plus nitrite ion will be recommended by Drinking Water Standards. Because the nitrite ion is the substance actually responsible for causing methemoglobinemia, a combined limit on the two ions is more significant than a limit on nitrates only.

pH

Most unpolluted waters have pH values within the range recommended as a permissible criterion. Any pH value within this range is acceptable for public water supply. The further selection of a specific pH value within this range as a desirable criterion cannot be made.

PHOSPHORUS

Establishing criteria on phosphorus concentrations has been considered but no generally acceptable limit has been established because of the complexity of the problem. The purpose of such a limit would be twofold:

1. To avoid problems associated with algae and other aquatic plants, and

2. To avoid coagulation problems due particularly to complex phosphates.

Phosphorus is an essential element for aquatic life as well as for all forms of life and has been considered the most readily controllable nutrient in efforts to limit the development of objectional plant growths. Evidence indicates that high phosphorus concentrations are associated with the eutrophication of waters that is manifest in unpleasant algal or other aquatic plant growths when other growth-promotion factors are favorable; that aquatic plant problems develop in reservoirs or other standing waters will collect phosphates from influent streams and store a portion of these within the consolidated sediments; that phosphorus concentrations critical to noxious plant growths will vary with other water quality characteristics, producing such growths in one geographical area but not in another.

Because the ratio of total phosphorus to that form of phosphorus readily available for plant growth is constantly changing and will range from two to 17 times or greater, it is desirable to establish limits on the total phosphorus rather than the portion that may be available for immediate plant use. Most relatively uncontaminated lake districts are known to have surface waters that contain 0.01 to 0.03 mg/l (elemental phosphorus) at 48 percent of the stations sampled across the Nation. Some potable surface water supplies now exceed 0.2 mg/l(as elemental phosphorus) without experiencing notable problems due to aquatic growths. A concentration of 0.05 mg/l total phosphorus (as elemental phosphorus) would probably restrict noxious aquatic plant growths in flowing waters and in some standing waters. Some lakes, however, would experience algal nuisances at and below this level.

Critical phosphorus concentrations will vary with other water quality characteristics. Turbidity and other factors in many of the Nation's waters negates the algal-producing effects of high phosphorus concentrations. When waters are detained in a lake or reservoir, the resultant phosphorus concentration is reduced to some extent by the growth of organisms and released by subsequent decomposition in fecal pellets or dead organisms.

At concentrations of complex phosphates of the order of 0.1 mg/l difficulties with coagulation are experienced.

TOTAL DISSOLVED SOLIDS

Drinking Water Standards recommend that total dissolved solids not exceed 500 mg/l where other more suitable supplies are available. It is noted, however, that some streams contain total dissolved solids in excess of 500 mg/l. For example, the Colorado River at the point of

withdrawal by the Metropolitan Water District of Southern California has a total dissolved solids concentration up to 700 mg/l.

High total dissolved solids are objectionable because of physiological effects, mineral taste, or economic effect. High concentrations of mineral salts, particularly sulfates and chlorides, are associated with corrosion damage in water systems. Regarding taste, on the basis of limited research work underway in California, limits somewhat higher than 500 mg/l are probably acceptable to consumers of domestic water supplies. It is likely that levels set with relation to economic effects are controlling for this parameter.

Increases in total dissolved solids from those normal to the natural stream are undesirable and may be detrimental.

It is recommended that the permissible value for total dissolved solids be set at 500 mg/l in view of the above evaluation.

Industrial water supplies include a wide variety of uses, and as a consequence, there is a correspondingly large number of industrial water quality requirements. Not only do criteria vary with the type of industry, but they vary within individual industrial plants where water is used for multiple purposes, each having different quality requirements.

Table 128 presents water quality characteristics for selected industrial water supplies.

Agricultural water use may be classified in three categories: farmstead use, livestock use, and irrigation use. Key water quality criteria for agricultural uses are presented in table 129.

Quality standards for farmstead and livestock use are set to assure the same basic object as drinking water standards for human consumption, which is to preserve health and well being. The limits of water quality tolerance for livestock are more lenient than for human beings. In some species, lactation is known to diminish with continuous drinking of highly mineralized water. Animals can almost always adjust to high mineral concentrations; however, sudden increases may cause poisoning. Water polluted with large numbers of organisms, such as blue-green algae, should be avoided.

Table 128 - Water Quality Characteristics for Selected Industrial Water Supplies

Characteristic	Boiler Makeup Water: Industrial 0 to 1,500 psig	Boiler Makeup Water: Utility 700 to 5,000 psig	Cooling Water: Fresh: Once through	Cooling Water: Fresh: Makeup recycle	Cooling Water: Brackish: Once through	Cooling Water: Brackish: Makeup recycle	Process Water: Food and Kindred Products SIC-20	Process Water: Textile Industry SIC-22	Process Water: Lumber Industry SIC-24	Process Water: Pulp and Paper Industry SIC-26	Process Water: Chemical Industry SIC-28	Process Water: Petroleum Industry SIC-29
Calcium (Ca)	-	-	500	500	1,200	1,200	For the above	-	-	-	200	220
Magnesium (Mg)	-	-	-	-	-	-	category the	-	-	-	100	85
Sodium and Potassium	-	-	-	-	-	-	raw surface	-	-	-	-	230
(Na + K)							supply should					
Bicarbonate (HCO_3)	600	600	600	600	180	180	be that pre-	-	-	-	600	480
Sulfate	1,400	1,400	680	680	2,700	2,700	scribed by	-	-	-	850	570
Chloride (Cl)	19,000	19,000	600	500	22,000	22,000	the NTA Sub-	-	-	200 2/	500	1,600
Nitrate (NO_3)	-	-	30	30	-	-	committee on	-	-	-	-	8
Dissolved Solids	35,000	35,000	1,000	1,000	35,000	35,000	Water Quality	150	-	1,080	2,500	3,500
pH Units	-	-	5.0-8.9	3.5-9.1	5.0-8.4	5.0-8.4	Requirements	6.0-8.0	5.9	4.6-9.4	5.5-9.0	6.0-9.0
Temperature, F	120	120	100	120	100	120	for Public	-	-	95 3/	-	-
							Water Supplies.					

1/ Water containing in excess of 1,000 mg/1 dissolved solids.
2/ May be $\leq$ 1,000 for mechanical pulping operations.
3/ Applies to bleached chemical pulp and paper only.

NOTE: Application of the above values should be based on Part 23 ASTM book of Standards or APHA Standard methods for the examination of water and wastewater. (Unless otherwise indicated, units are mg/1 and values are maximums. No one water will have all the maximum values shown)

Table 129- Key Water Quality Criteria for Agriculture Uses

FARMSTEAD USE

Characteristic	General Farmstead Use	Additional Special-Use Requirements
Taste and oder	Substantially free	
Color	do	
pH	6.0 to 8.5	6.8 to 8.5 dairy sanitation
Total dissolved inorganic solids	500 mg/1 (under certain circumstances, higher levels are acceptable.)	
Dissolved organic compounds	No recommendations for total organics.	
Nonpathogenic microorganisms	To conform to USPHS drinking water standards.	For dairy sanitation, water should not contain more than 20 organisms per ml and contain not more than 5 lypolytic and/or proteolytic organisms per ml.

LIVESTOCK USE

Characteristics	Recommendations
Total dissolved solids (TDS)	10,000 mg/1, depending upon animal species and ionic composition of the water.
Organic Substances:	
Algae (water bloom)	Avoid abnormally heavy growth of blue-green algae.
Parasites and pathogens	Conform to epidemiological evidence.
Dissolved organic compounds	Biological accumulation from environmental sources, including water, shall not exceed established legal limits in livestock products.

IRRIGATION USE

Crop Response	TDS mg/1	EC[1] mmhos/cm
Water for which no detrimental effects will usually be noticed	500	0.75
Water which can have detrimental effects on sensitive crops	500 - 1,000	0.75 - 1.50
Water that may have adverse effects on many crops and requiring careful management practices	1,000 - 2,000	1.50 - 3.00
Water that can be used for salt-tolerant plants on permeable soils with careful management practices	2,000 - 5,000	3.00 - 7.50

1/ Electrical conductivity

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